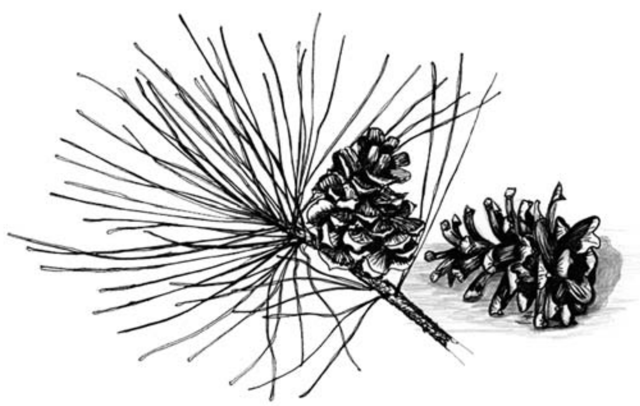
Investigating Fire Ecology
in Ponderosa Pine Forests

2004/First Edition

A Field Guide for
Sixth Grade Teachers



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The listing of a resource in this curriculum does not presume its endorsement by the National Park Service.

This guide may be obtained by participating in a teacher workshop or by visiting the Bandelier website at www.nps.gov/band.

Teachers are encouraged to offer their feedback by filling out the enclosed evaluation form or contacting the VTF or NPS directly.

Printed on recycled paper using soy-based inks.

PREFACE

When the more than 18,000 residents of Los Alamos, New Mexico awoke on May 6, 2000, they were unaware that within the next ninety-six hours their sleepy, relaxed mountainside community would be forever changed. A small wildland fire approximately five miles southwest of town was rapidly growing. The fire was named for the peak of its origin, Cerro Grande. As residents uneasily watched the column of smoke rising from the thickly forested backdrop to town, over the next days firefighters battled the blaze with mixed success.

On the morning of Wednesday, May 10th, representatives of a wide range of government agencies, including New Mexico Governor Gary Johnson, visited Los Alamos to assess the fire. When the officials headed out of town around noon, the fire seemed under control. As I was escorting Governor Johnson to his helicopter, our ears were filled with the cries of cell phones and a sudden, exponential increase in radio traffic. Something had gone terribly wrong. Whipped into new life by penetrating winds from the southwest, the Cerro Grande Fire exploded in Los Alamos Canyon, just two miles south of town. In a few minutes, fueled by tinder dry forests and wind gusts to 75 mph, plumes of smoke rose thousands of feet into the sky.The fire erupted into a two-mile- wide crown-fire that marched determinedly toward the town. Within the next four hours, the citizens of Los Alamos, except for police and fire personnel, were evacuated. Twelve hours later, residents of White Rock, eight miles to the southeast, were told to evacuate.

Crown fires are like tsunamis with two hundred feet waves. There s nothing you can do to stop them. Bill Armstrong, United States Forest Service (USFS)

Indeed, nothing could stop the wall of flame from sweeping through the northern parts of Los Alamos. By the next morning, the Cerro Grande Fire had grown from 4,300 acres to over 20,000 acres. In less than 24 hours it consumed over 230 structures, many the homes of 429 families. In some neighborhoods, the complete infrastructure melted and nothing remained except for smoldering piles of ash and rubble, lonely stone chimneys, and the skeletons of cars. By Saturday, May 14th, the flame front worked its way well past the town, but the fire had doubled in size to over 40,000 acres. In its wake were barren soils and hundreds of thousands charred, blackened telephone-pole sticks that were once the ponderosa pines of the Santa Fe National Forest.

That morning, some of the families from the highly-impacted neighborhoods were bused through the town to view what remained of their homes. Counselors were available to address the grief, despair and loss. The next day, White Rock residents were permitted to return to their community. Over the next seven days, the rest of the community was permitted to return to their homes. It was two weeks before the town held some resemblance of normalcy when the Los Alamos Public Schools re-opened.

Throughout the repopulation of the town, one question was asked repeatedly:

How can I help? More than a few people wanted to get involved in the rehabilitation effort on the mountain. Although untrained personnel are not permitted to enter an active fire perimeter, the overwhelming desire for citizens to volunteer in the burned area brought representatives from the various agencies around the community to form a Multi-Agency Volunteer Task Force (MAVTF).

As a Los Alamos Police Officer, I held various assignments during this time: airport security, dignitary protection, environmental damage and safety assessment and organizing the re-population. None of my duties prepared me for my next task: MAVTF asked me to become the Incident Commander for all volunteer efforts.

I got an inkling of what I was in for as the Incident Commander of MAVTF over the Memorial Day weekend. A few dozen citizens some of them now without homes threw away their holiday and showed up to volunteer to fill sandbags for the mitigation of flooding when the annual monsoon rains arrived early. One week later, the first Saturday in June, almost 500 volunteers showed up to do watershed stabilization work within the burned area.

An unanticipated synergy developed between a contagion of good will and the challenge to the rehabilitate the community. It was a classic example of if people thought good things, then good things could happen. Fire fighting professionals from a multitude of agencies on local, state, and federal levels displayed an unprecedented creativity and constructivism to organize, operationally and logistically, such a mass undertaking. It is no easy task to handle 500 volunteers in a day! Tools, meals, transportation, and safety were just a fraction of the planning process. Volunteers arrived from not only the local area, but from as far away as Tennessee. Regardless of their origin, every single person contributed to a sense of caring, love and compassion for the community of Los Alamos and the landscape of the Jemez Mountains. By the end of the summer these Saturday morning work parties produced in excess of 13,000 hours of labor on tasks such as raking, seeding and mulching the perimeters of the town in hopes of mitigating any further damage from the nearing monsoon rains.

It was my great fortune to remain Incident Commander for the volunteer projects throughout the summer and early fall of 2000. I was eventually placed on detached service to the United States Forest Service and transferred to the Bitterroot Fires in the Montana rehabilitation project before retiring from the Los Alamos Police Department in January 2001.

By mid-summer, the overwhelming success of MAVTF was no surprise. From the community groundswell, a host of dedicated and sincere people joined the team.

John Hogan, a United States Geological Survey biologist assigned to the Jemez Mountains, was in on the volunteer effort from the start. Through the initial stages of the fire, John worked fighting spots fires and assisting where needed.
At the start of the second week, he called me to ask where he could be of better use. I had known John for almost fifteen years and knew from the moment he became engaged that his knowledge and expertise of fire ecology would be of huge benefit to the community.

John recognized that rehabilitation would continue for years and that the most solid response to wildfire would be community-based. He freely gave his enthusiasm and relentless energy to the continuation of the volunteer efforts. Without his contributions, the volunteer rehabilitation effort would not have taken on such a broad outlook.

Craig Martin, a naturalist and author of seventeen books, is the other key founder of the VTF. Although the two had never met, John knew of Craig s devotion to the ecology and recreational potential of the Jemez Mountains and realized MAVTF might benefit from Craig s input. Involved in the weekend projects as a volunteer and writing on fire issues for the local newspaper, Craig ignored several messages on his answering machine from a John Hogan. John s persistent attempts paid off. The community and mountain are extremely glad he did. Craig s leadership, intensity, and demeanor have been a cornerstone for the VTF s success.

Laura Patterson also had a serendipitous invitation to this adventure. Laura is an elementary school teacher, and, like me, a martial artist. While working out one evening I asked her if she was free the following day to attend a MAVTF meeting regarding Cerro Grande Fire rehabilitation. Laura jumped at the offer. Always searching for ways to actively engage her students in learning, she was searching for a way to involve her 6th graders in post-fire activities. Laura was leading with her heart: 30% of the student body of her school lost their homes to the Cerro Grande Fire. Laura and fellow teacher and innovator Gerry Washburn made it part of their classroom routine to take students on the mountain to rebuild the Quemazon Nature Trail. Both physically reconstructing the trail and rejuvenating it were educational experiences. Through Laura s and Gerry s commitment and love of teaching, their students accomplished a feat few 6th grade classes can take credit for. As a team, Laura, Craig, and John promoted and developed the curriculum project that drove this publication.

When I think back on those first few meetings of the Multi-Agency Volunteer Task Force, one conversation stands out. John Hogan and I agreed that there was only one rule that attendees had to abide by: Make sure you leave your ego hanging at the door before entering, because we have a lot of work to do and we don t have time to waste. Each of us involved in this evolving endeavor has tried to keep our focus on future generations and how we might help them to be a little more knowledgeable about fire ecology. This entire experience has been more rewarding than we could possibly appreciate or comprehend. We only encourage each of our readers to take a risk, and when you think you have an opportunity to help, please do not hesitate, but act.

Al Toth, Retired LAPD, former Incident Commander for the MAVTF

THE VOLUNTEER TASK FORCE

The Volunteer Task Force (VTF) is a community-based group focused on environmental education and ecological restoration. Formed as a multi-agency coordinating committee to handle the outpouring of volunteers in the wake of the Cerro Grande fire in Los Alamos, New Mexico, VTF evolved into a non-profit corporation that continues to provide educational and community service opportunities to students and adults in Los Alamos and throughout northern New Mexico. VTF mixes service learning with ecological monitoring to provide students the opportunity to generate real data that can be used as a management tool. Utilizing the Cerro Grande burned area as a natural laboratory, VTF supervises student projects on post-fire recovery in the areas of ground cover regeneration, planted seedling mortality, geomorphic changes to stream channels, and other monitoring. VTF specializes in hands-on projects that illustrate the importance of fire in ponderosa pine ecosystems, and that deal with issues of forest health and ecological stewardship in the Southwest. By combining science and service, VTF generates student ownership in the surrounding landscape.

A month after the Cerro Grande fire, teachers from Mountain Elementary School in Los Alamos where 30 percent of the students lost their homes in the blaze joined the VTF in developing a trail rebuilding project for sixth grade students. With the support of the National Park Service, VTF and Mountain School staff and students began the reconstruction of the Quemazon Nature Trail in September 2000. The program included presentations, activities, and outdoor classroom experiences to provide students with an overall understanding of the past and future of the forest along the trail. In 2001 and 2002, the program expanded into all the schools in Los Alamos and to schools throughout northern New Mexico. Continuing support from the National Park Service, the United States Geological Survey, and local businesses has brought this program to more than 4,000 students.

VTF continues to design and implement ecological and recreational restoration projects in northern New Mexico. In the group s first three years, it amassed more than 44,000 hours of volunteer time from regional communities.

THE NATIONAL PARK SERVICE

The National Park Service cares for special places saved by the American people so that all may experience our heritage.

Experience Your America

On August 25, 1916, President Woodrow Wilson signed the act creating the National Park Service, a new federal bureau in the Department of the Interior responsible for protecting the 40 national parks and monuments then in existence and those yet to be established.

Bandelier National Monument

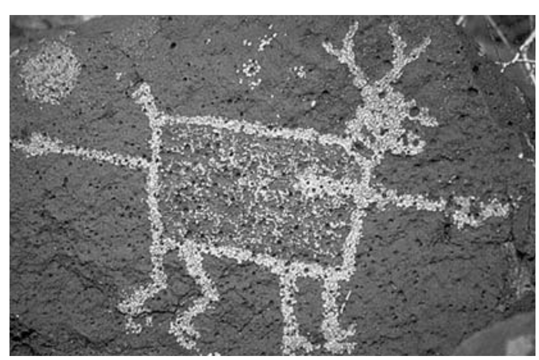
This Organic Act of 1916 states that the Service thus established shall promote and regulate the use of Federal areas known as national parks, monuments and reservations . . . by such means and measures as conform to the fundamental purpose of the said parks, monuments and reservations, which purpose is to conserve the scenery and the natural and historic objects and the wild life therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations.

Pecos National Historic Park

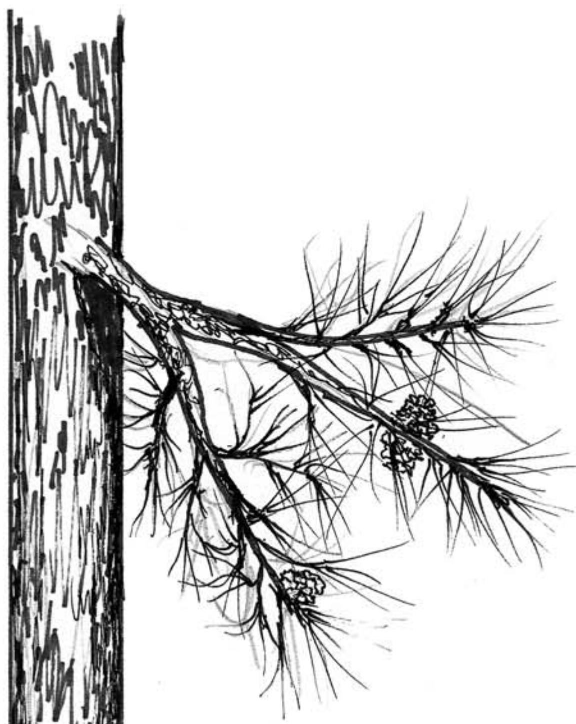
The National Park Service still strives to meet these original goals, while filling many other roles as well: guardian of our diverse cultural and recreational resources; environmental advocate; world leader in the parks and preservation community; and pioneer in the drive to protect America s open space.

The National Park System of the United States comprises over 380 areas covering more than 83 million acres in 49 states, the District of Columbia, American Samoa, Guam, Puerto Rico, Saipan, and the Virgin Islands. Although not all parks are as well known as the Grand Canyon and Yellowstone, all are areas of such national significance that they have been included in the National Park Service ancient pueblos, battlefields, birthplaces, memorials, recreation areas, and countless other wonders.

The future of the National Park System lies in understanding and protecting its meanings, values, and resources. Each part of the system represents the United States and a part of our heritage. Preservation of individual sites and the entire system will ensure the essence of quality remains in our lives and the lives of all future generations.



Petroglyph National Monument



Investigating Fire Ecology

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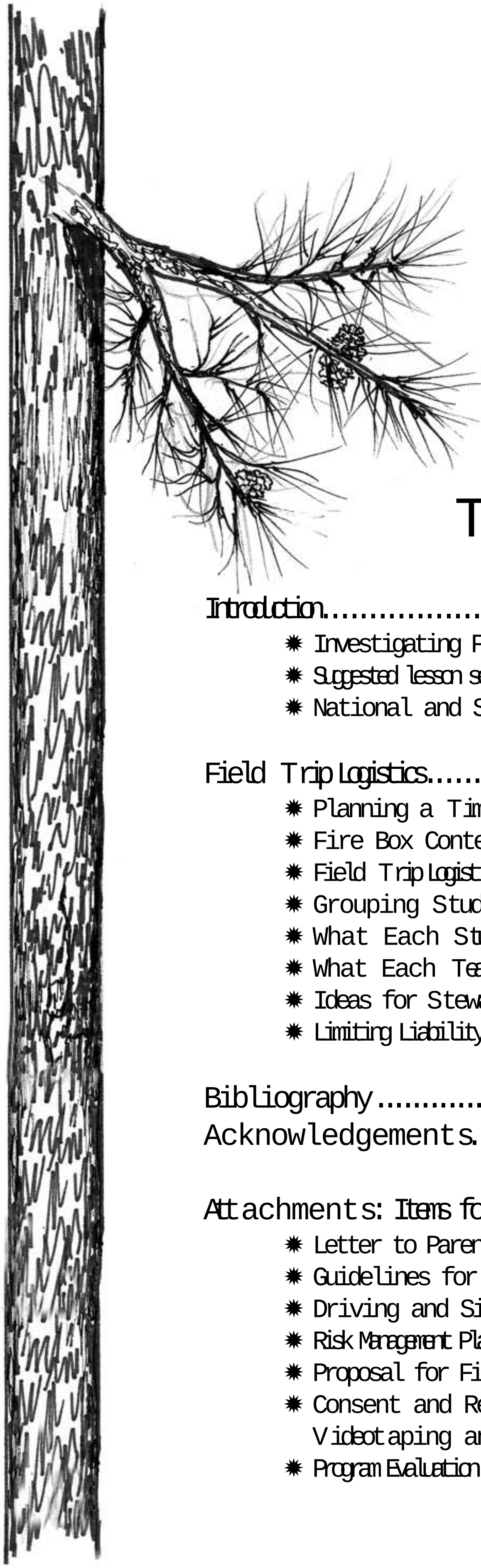

Investigating Fire Ecology

Teacher Preparation

Investigating Fire Ecology: An Overview

Investigating Fire Ecology is a curriculum designed to provide students with interactive opportunities to construct a basic understanding of the sciences associated with wildfire ecology. The disciplines of forestry, biology, and geology are introduced to students using an interactive, hands-on, field-based investigation process. The guide is primarily written for 6th grade but is easily adaptable to accommodate grades 5 through 8.

Activities are divided into three sections: prepatory classroom lessons, an educational and work focused field trip, and post-trip analysis, review and instruction. All activities have been field tested and reflect facts and approaches utilized by professionals in each of the respective fields.

The lessons center on ecological recovery from fire and related topics that encourage students to collect and analyze their own data. Throughout the guide students are offered opportunities to examine multiple perspectives of post-fire ecology and to gain an understanding of the complexity of the issues, as appropriate for their developmental level.

The lessons present topics to students in a manner that integrates critical thinking processes such as problem definition, forming hypothesis, collecting and organizing data and information, synthesizing, performing analysis, formulating alternative solutions, identifying optimal courses of action, and drawing conclusions.

Students are encouraged throughout to practice interpersonal and communication skills, including oral and written communication, group cooperation, leadership, and citizenship skills. The activities are designed to sharpen basic classroom and field skills such as observation, data collection, and data analysis. Lessons incorporate the use of technology in the form of computers, software, and mapping using Global Positioning Systems (GPS).

Delivery is accomplished via a combination of lecture, discussion, field trips, cooperative learning, and independent work in an environment that encourages creative expression. Each lesson begins with an essential question that challenges students to broaden their thinking and sharpen their research skills. All topics are relevant to the students daily lives and reflect real-world experiences.

The program is interdisciplinary and combines math, science, social studies, art, geography, language arts, and computers. All lessons are carefully aligned with the National Science Standards and New Mexico Science Standards.

A variety of performance assessment techniques are included, such as pre- and post-activity sheets that emphasize open ended questions, data analysis, and journal entries. Student outcomes are tied to goals and objectives. Expectations are clearly expressed at the onset of each lesson to provide for a more direct and objective ability to perform assessment.

Lessons can be implemented sequentially or individually depending on teacher preference and the attributes, interests, and characteristics of your community and school.

The study of fire ecology will challenge students, facilitate developmental skills, and impart specific scientific knowledge that prepares students for more advanced course work. It encourages active learning and is an exciting way to investigate these issues that exist within every community.

Suggested Lesson Sequence

Pre-Visit: Time needed: 4 hrs

- Activity #1: Fire History of Ponderosa Pine Ecosystems
  Students read a fire history newspaper and complete worksheets to understand the fire regime in ponderosa pine forests.
- Activity #2: Why Do Forests Burn? Exploring the Fire Triangle
  Students learn how forest density, slope and weather conditions affect the nature of wildland fire.
- Activity #3: Wildfire & Native Plants: Identification of Trees, Shrubs and Understory Plants
  Students identify common trees, shrubs and understory plants in a ponderosa pine forest using dichotomous keys and drawings.
- Activity #4: Measuring the Earth from the Ground Up
  Students use GPS units to map specific locations in preparation for the field trip.
- Activity #5: Preparing for the Field Trip: Field Journals and Photo Collages
  Students prepare a field journal and learn about photography in preparation for the field trip.

On-Site: Time needed: 6 hours

- Field Journal: Students complete their field journal by recording data from their plot study, identifying plant species, and recording observations in burned and unburned areas.
- Optional Field Trip Extension: Teachers may select a site stewardship project in an area affected by a wildfire.

Post-Visit: Time needed: 6 hours

- Activity #1: What Does It All Mean? Analysis of Plot Data
  Students analyze the data collected during their field trip.
- Activity #2: Wildfire and Native Plants: Creating a Field Guide
- Activity #3: Using Observations to Express Feelings: Writing and Photo Collage
  Students reflect on the effects of wildfire and on their field trip observations.
- Activity #4: Should We Thin All the Ponderosa Pine Forests? A Forest Management Plan
  Students develop a forest management plan for maintaining healthy ponderosa pine forests.
- Activity #5: Be Prepared: Defensible Space
  Students create a defensible space plan for their home.

This curriculum is designed to replace one of your ecology units. To make it relevant, it is important for you to link it with the national science standards, national art standards, New Mexico content standards & benchmarks, and/or New Mexico visual art standards & benchmarks.

The skills listed below identify those skills that students will gain while participating in the activities found in this guide:

Mathematics

Understand meaning and use of random samples
Use estimation with measurement
Solve problems by collecting, organizing, and analyzing data
Look for a pattern in data
Classify and measure angles
Understand the processes of basic mathematical operations
Solve problems with ratios and proportions
Generate and solve word problems using real data
Use and evaluate problem-solving strategies
Collect, organize and analyze data
Compare quantities in table, graph, and pictorial form
Use calculators to solve and check problems

Science

Use tools to collect data, to measure, and to manipulate objects
Investigate and solve problems about the movement of living things
Make predictions, and observations, and draw conclusions
Use a variety of strategies to solve problems
Develop predictions based on prior knowledge
Explore personal risks and costs to society in dealing with environmental hazards
Understand that some events in nature have a repetitive pattern
Determine the requirements for living things to survive
Identify the appearance of diversification of life forms
Present results of investigations in several ways (individual and group presentation, logbooks) and using various forms (graphs, charts, reports)
Use sensory observations to describe the physical properties of objects
Observe changes in animals, plants, and the environment

Communication

Respond to reading through writing, speaking, and art
Prepare, organize and make oral presentations
Stay on topic when speaking
Use appropriate grammar when speaking
Use voice, body language, notes and visual aids to correctly engage the audience when speaking

Use basic three-part format in organizing presentation
Maintain listening skills
Use peer review to revise and edit
W ork cooperatively in groups, state opinions, and discuss reactions

Social Studies

Explain obligations and responsibilities of citizenship
Explain roles of citizens in political decision-making.

National Science Standards Grades 5-8	National Art Standards Grades 5-8
Content Standard A: Science as Inquiry Abilities to do scientific inquiry Understandings about scientific inquiry	Content Standard 1: Understanding and applying media, techniques, and processes a.b.
Content Standard C: Life Science Regulation and behavior Populations and ecosystems Diversity and adaptations of organisms	Content Standard 2: Using knowledge of structures and functions a.b.c.
Content Standard E: Science and Technology Abilities of technological design Understandings about science and technology	Content Standard 3: Choosing and evaluating a range of subject matter, symbols, and ideas a.b.
Content Standard F: Science in Personal and Social Perspectives Populations, resources, and environments Natural hazards Risks and benefits Science and technology in society	
Content Standard G: History and Nature of Science Science as a human endeavor Nature of science History of science	

New Mexico Visual Art Standards and Benchmarks Grades 5-8			
Content Standard 1: Learn and develop the essential skills and technical demands unique to dance, music, theater/drama, and visual art. Benchmarks A1, B1	Content Standard 2: Use dance, music, theatre/drama, and visual arts to express ideas Benchmarks A1, A2, B1, B2	Content Standard 3: Integrate understanding of visual and performing arts by seeking connections and parallels among art disciplines as well as other content areas. Benchmarks A1, B1	Content Standard 4: Demonstrate an understanding of the dynamics of the creative process. Benchmarks A1, B3, B4

New Mexico Science Content Standards, Benchmarks, and Performance Standards, 6th Grade

Strand I Scientific Thinking and Practice

Standard I Understand the processes of scientific investigations and use inquiry and scientific ways of observing, experimenting, predicting, and validating to think critically.

Benchmark I Use scientific methods to develop questions, design and conduct experiments using appropriate technologies, analyze and evaluate results, make predictions, and communicate findings.

Performance Standards:
1. Construct appropriate graphs from data and develop qualitative and quantitative statements about the relationships between variables being investigated.
2. Examine the reasonableness of data supporting a proposed scientific explanation.
3. Justify predictions and conclusions based on data.

Benchmark II: Understand the processes of scientific investigation and how scientific inquiry results in scientific knowledge.

Performance Standards:
1. Understand that scientific knowledge is continually reviewed, critiqued, and revised as new data become available.
2. Understand that scientific investigations use common processes that include the collection of relevant data and observations, accurate measurements, the identification and control of variables, and logical reasoning to formulate hypotheses and explanations.
3. Understand that not all investigations result in defensible scientific explanations.

Benchmark III: Use mathematical ideas, tools, and techniques to understand scientific knowledge.

Performance Standards:
1. Evaluate the usefulness and relevance of data to an investigation.
2. Use probabilities, patterns, and relationships to explain data and observations.

Strand II: Content of Science

Standard II (Life Science) Understand the properties, structures, and processes of living things and the interdependence of living things and their environments.

Benchmark I Explain the diverse structures and functions of living things and the complex relationships between living things and their environments.

Performance Standards:
1. Understand how organisms interact with their physical environments to meet their needs (i.e., food, water, air) and how the water cycle is essential to most living systems.
2. Describe how weather and geologic events (e.g., volcanoes, earthquakes) affect the function of living systems.
3. Describe how organisms have adapted to various environmental conditions.

Benchmark II: Understand how traits are passed from one generation to the next and how species evolve.

Performance Standards:
1. Describe how species have responded to changing environmental conditions over time (e.g., extinction, adaptation).

Strand III: Science and Society

Standard I Understand how scientific discoveries, inventions, practices, and knowledge influence, and are influenced by, individuals and societies.

Benchmark I Explain how scientific discoveries and inventions have changed individuals and societies.

Performance Standards:
1. Examine the role of scientific knowledge in decisions (e.g., space exploration, what to eat, preventive medicine and medical treatment).
2. Describe the technologies responsible for revolutionizing information processing and communications (e.g., computers, cellular phones, Internet).

FIELD TRIP LOGISTICS
for
Investigating Fire Ecology

Planning a Time and Selecting a Location

When: The field trip outlined in this guide may be taken year-round, but fall and late spring are the best times for avoiding snow. Rain is most prevalent during the summer monsoon season, usually in July and August.

Where: Teachers need to select a location for the field trip. Any ponderosa pine forest will work if you can identify the burned vs. unburned areas or treated vs. untreated areas. We recommend one of the following locations:

Ponderosa Campground, Bandelier National Monument

This campground may be used for day use or overnight field trips. Located on State Route 4, this group campground has two group sites that can accommodate up to 50 people each. Reservations are required for overnight use and may be made by calling (505) 672-3861 ext. 534 between 9 am and 4 pm (Monday-Friday).

Rendija Canyon, Los Alamos

This day-use area is located on the Santa Fe National Forest at the trailhead for the Pajarito Trail. No bathroom facilities, water, or camping are available. The trailhead has a parking area suitable for buses. If more than 70 students will participate in the field day at this site, contact the USDA Forest Service Espaæola Ranger District office at (505) 753-7331 for a permit to use the site.

East Fork of Jemez River Trailhead, Santa Fe National Forest

This day-use area has primitive bathroom facilities and parking for buses. No water is available at the site. If more than 70 students will participate in the field day at this site, contact the USDA Forest Service Jemez Ranger District office at (505) 829-3535 for a permit to use the site.

Weather: The chart on the next page lists average climate expectations. Weather is subject to change quickly and can vary dramatically for different locations throughout the Jemez Mountains, especially at the higher elevations.

CLIMATE AVERAGES FOR LOS ALAMOS, NEW MEXICO			
	Maximum Temperature	Minimum Temperature	Mean Precipitation
January	39.6	18.5	0.89
February	43.4	21.8	0.73
March	49.7	26.8	1.06
April	58.8	33.9	0.98
May	67.9	42.7	1.23
June	78.1	51.9	1.38
July	80.6	55.6	3.01
August	77.8	53.9	3.72
September	72.4	48	1.79
October	61.7	37.7	1.52
November	48.8	26.8	0.94
December	40.8	19.8	0.95

Seasonal events: Consult the chart below to assess which months may be best for a class to visit the Jemez Mountains.

April	Turkey vultures and birds of prey migrate through the Jemez. Early-season wildflower displays of Rocky Mountain clematis, Easter daisy, and pasqueflower.
May	Elk calves are born in the Valles Caldera.
June	Wildflowers in the mountains reach their peak with mountain parsley, Indian paintbrush, Calypso orchids, New Mexico penstemon and dozens of other species in bloom.
July	Summer thunderstorms bring green to the mountains.
August	Dances at Jemez Pueblo
September	Bull elk bugle in the Valles Caldera. Chenopods in the burned areas turn brilliant red.
October	Aspens turn golden as the days grow shorter

Guided or self-guided trips: This guide may be used by teachers as a self-contained lesson sequence. A Fire Box containing the necessary equipment to complete the lesson sequence is available (see next page).

Reservations: Teachers who would like more assistance in presenting the field components of this guide can contact the Volunteer Task Force in Los Alamos to make reservations for a field day. Please allow at least 6 hours at the site for the field day. VTF instructors can accommodate up to 70 students per day. Reservations should be made at least one month in advance. There is no charge for the field day. Make reservations by contacting the VTF at info@volunteertaskforce.org. .

Fire Box Contents

Fire boxes are available for check out at the Bandelier visitor center or through the Volunteer Task Force (VTF). Make a reservation by calling the Bandelier Visitor Center (505-672-3861 #517) or by emailing the VTF at info@volunteertaskforce.org. The fire boxes contain the following items:

- 4 GPS receivers
- 4 100-meter measuring tapes
- 6 50-meter measuring tapes
- 4 rolls of surveyor stape
- Wooden stakes
- Pin flags
- 15 blue Nerf balls
- Yellow surveyor tape for arm bands for fire tag
- Samples of ponderosa pine, limber pine, juniper, piaon pine, Douglas fir
- 4 three-foot ropes or plastic circles
- First-aid kit
- Field guides for plants and animals

Field Trip Logistics

The success of any field trip requires careful attention and detailed planning. The following tips will help ensure that your field trip will be a rewarding experience for all.

1. Pre-visit the field site. Check for any potential problems (see safety hazards).

2. Arrange for bus transportation and funding well in advance.

3. Inform your school secretary and principal of your trip well in advance.

4. Involve all staff in the planning of trips. Give plenty of notice to the classrooms that students will miss the day of the trip. (i.e., computers, band and orchestra, music, art, library).

5. Handicapped students may require special arrangements, for both transportation and field activities. Make necessary contacts to ensure these students will benefit from the experience.

6. Prepare a short handout for parents and volunteers that describes the details and objectives of the field trip.

7. If some students remain in school on trip day, make sure there is a plan for where they are to be and who will be responsible.

8. Create a master permission slip form indicating the destination, purpose of the field trip, type of transportation, and approximate time of return. Use the bottom of the page as a detachable permission slip so that parents can give their consent and still keep the information. Leave a space for parents to indicate whether their child is likely to suffer from allergies on this trip. Leave another spot for parents to declare whether they ll be joining you. Attach the What Students Need form or the letter explaining the trip to the permission slip. Distribute the permission slips about a week before the trip. You should never take a student on a field trip without a parent s signed consent.

9. Discuss Guidelines for Field Trips and What Students Need with students one week in advance. Have both students and parents sign this form along with the permission slip.

10. Set up a datatable or spreadsheet with information about your students and their parents/guardians with contact information. Information should include student and parent name, address, emergency contact information and any important medical information. This student information should accompany you on all field trips.

11. Have students wear name tags. Color-code them for group identification.

12. Have precise directions to the field site available for the bus driver and all other participants.

13. Check the weather forecast a day or two ahead of time. Do not hesitate to cancel on the day of the trip if the weather is questionable.

14. Leave your cell phone number with the school secretary on the day of the trip.

15. Each teacher should be in charge of their own students.

16. Assign specific responsibilities for parents and volunteers. Remind participants that field trips are very task-intensive and not a time for them to be talking to each other. Tactfully let them know that they are role models, and enforce that.

17. Extend an invitation to other interested community members (school board members, journalists, former students).

18. When students are walking, there should always be one adult in front, one in the middle, and one at the end of the line.

19. Teachers should be accountable for all their students at all times.

20. Each teacher should carry a complete, transportable first aid kit. One teacher should have an Epi Pen (epinephrine) and be trained in how to use it.

21. Pack extra water, clothes, and sunscreen.

22. During the trip, students should get the teacher s permission to go to the bathroom and never go alone.

23. W rite thank you notes to the parents and volunteers who helped you. You may want to acknowledge their help in a school newsletter.

24. For later use, maintain a file with information on your field trip s highlights, observations and evaluations, and things for which you could have better prepared.

TEACHER PREPARATION

Grouping Students

There are many ways to group students. If left up to the students, they will naturally want to team up with their friends. In some cases this works but be aware of potential behavior problems. Consider the following when grouping students:

Academic needs
- Reading levels
- Learning styles
- Math skills
- Problem solving skills
- Work habits
- Organizational skills
- Behavioral skills
- Content or subject matter

Create groups that have students skilled in different areas. Include in each group one student who is good at math, a good reader, and one who has good interpersonal skills.

The field activities in this guide are best done in groups of four. Divide students into groups before the field trip. Assign each group a color. Make name tags for each student that include the color code. Name tags can be strips of masking tape.

What Each Student Needs

- Rain gear
- Warm layered clothing
- Gloves and hat
- Sunscreen and sunglasses
- Hearty snack or lunch
- Water
- Clipboard with field journal and 2 pencils
- Colored pencils
- Permission slip
- Inhalers (if needed)
- Sturdy hiking shoes

What Each Teacher Needs

- Rain gear
- Warm, layered clothing
- Gloves and hat
- Sunscreen and sunglasses
- Hearty snack or lunch
- Water
- Permission slips
- Pencil sharpeners and extra pencils
- Cell phone
- Garbage sack
- Sturdy hiking shoes
- First-aid kit
- Class list

What Each Parent Helper Needs

- Rain gear
- Warm, layered clothing
- Gloves and hat
- Sunscreen and sunglasses
- Class list
- Sturdy hiking shoes
- Hearty snack or lunch
- Copy of lesson plan
- Water

Optional

- Small backpack
- Binoculars
- Camera

Before You Head Out to the Field

Recruit parent volunteers: one adult for each group of four students is ideal. Make certain adults understand that they will be expected to help supervise students on the field trip. They should lend a hand, but permit the students to do the work.

Have students make legible name tags and color code the name tags for each group.

At the Field Site

The three activities of the field day are best done as a rotation through three stations. Allow at least 1.5 hours per station. In your schedule for the day, include time to walk to the site, for rotation between activities, for a snack, and for lunch. A comfortable schedule is:

Arrive at site
Unload buses and safety briefing: 15 minutes
Walk to first station: 10 minutes
First activity: 1.5 hours
Snack break and rotation to next activity: 15 minutes
Second activity: 1.5 hours
Lunch and rotation to next activity: 30 minutes
Third activity: 1.5 hours
Return to trailhead and load buses: 15 minutes

If necessary, the length of time at each activity can be reduced to 1 hour 15 minutes.

Ideas for Stewardship Projects for Students

A visit to a burned area offers students the opportunity to participate in service learning projects that teach about the importance of environmental stewardship and provide a valuable service to communities affected by wildfire. Teachers should contact local land managers or the Volunteer Task Force for assistance in planning stewardship projects.

Some ideas are:

- Plant seedlings in burned areas
- Make seed balls and scatter them in burned areas
- Do trail repair
- Monitor post-fire recovery of burned areas
- Slash removal in fuel reduction projects
- Make a video on burned area safety

Limiting Teacher Liability

Student participation in field trips can significantly compliment the existing educational program. While field trips have a very positive educational value when properly organized, care must also be taken to ensure that the trips are planned and conducted in a manner that ensures the protection and safety of students. All field trips introduce some risk. The objective is to manage that foreseeable risk by reducing or eliminating it. The most effective way to manage risk is to plan preventative steps that will minimize the possibility of an accident, and reduce both individual and district liability. Essentially, such steps include effective planning, prudent selection of activities, and careful supervision of those activities.

Although typically protected, a teacher, like everyone else, is vulnerable to damaging lawsuits. Often teachers pose legal questions that center around the topic of liability. The obligation or responsibility of teachers is determined through a combination of legislation, regulation, common law and school board policy or by-laws. Should it be found that a teacher did not properly fulfill their obligations, and that failure contributed specifically to the injury of a student, common sense dictates an increase in possible liability will arise. Most school districts have an insurance policy to protect teachers against the financial implication of such liability suites, and they will act on behalf and represent the teacher if they believe the teacher was acting within the bounds of his / her employment, and took prudent steps. The courts typically rule based upon a determination of whether the responsible individuals exercised the proper degree of caution and judgment. While this may appear daunting, it s not that difficult.

To avoid lawsuits, a teacher should assess all the possible risks associated with the activity and complete a risk management plan (sample attached) [1] This is a simple, documented approach to identifying the risks, and developing an approach to mitigate or eliminate them. Is the educational benefit of the trip worth the risks? Usually, but highly hazardous areas or exposure to undue risk should be avoided when picking locations and activities. A review of the specific district policies and associated requirements and safety guidelines may also help to answer that question.

The teacher responsible for planning, coordinating and implementing a field trip should complete a risk management plan, which includes an educational and safety assessment, for the principal s approval. You should have assistance personnel, and all of them, including parents should be trained in procedures and safety prior to the outing. Once the principal has approved a field trip the teacher should ensure that parents provide an informed written consent for their child to attend. The information to be provided should include a written, detailed itinerary including your educational assessment, the safety assessment, your expectations of students and parents, and supervision. Teachers should have student lists, phone contacts for school and parents, student medical information, first aid kits, and cell phones on each field trip. (See Planning Successful Field Trips for detailed planning tips).

[1] Note: This article is intended to be a helpful guide to planning field trips. Any inference that this constitutes specific legal advice is inappropriate; educators and administration are encouraged to secure specific, professional legal advice relative to issues / concerns / or the policies of their particular district and state.

If an accident occurs on the field trip, the teacher in charge must assess the situation, and if injuries have occurred, attend to the immediate medical concerns. Parents should be informed as soon as possible and a written accident report should be filled out within forty-eight (48) hours of the incident or as soon as possible upon return to the school. The principal should be notified at the earliest opportunity. Ensure that at least one supervisor is qualified in emergency first aid and CPR (cardiopulmonary resuscitation). Be aware of the location of the nearest accessible medical facility.

All participating students should use the transportation that has been arranged for the field trip unless other arrangements have been made between the parent and the teacher organizing the field trip. The principal should be informed in writing of any alternate arrangement for transporting students.

Students should never be left unattended. It is one of the surest ways for teachers to be found liable for student injuries.

It is the duty of the teacher to select field trip activities that can reasonably be conducted in a safe manner. All known hazardous conditions must be recognized.

Teachers and administrators cannot guarantee that injuries or accidents will not result from activities on field trips. They can only assume the responsibility of using good judgment and react sensibly in situations of potential danger. It is important that all teachers and principals become thoroughly familiar with the policies and procedures necessary in taking field trips to help protect themselves and their students. Preparation for a field trip is very important and should be a cooperative undertaking between teacher and students. Careful preparation prior to the trip will help ensure a safe and enjoyable educational experience.

Risk Management Planning
(This description explains how to complete the risk management form on page 42.)

Describe the proposed activity: (In order to determine risk, you must have a detailed idea of all the components of your program and the demands on students)

List the goals and anticipated outcomes: (Ultimately, you need to determine that the benefits and outcomes of the activity outweigh the potential risks the activity presents)

Who is responsible for instructing the students about the activity, safety, risks involved and risk management plans? (Risk management is an active process and must be communicated and shared with all participants. This plan only has value to the extent that it is brought to life through communication and diligence.)

What risk does this activity present?

Physical (i.e. physical injury to participants, staff and partners)

Emotional/psychological (i.e. stress, emotional trauma, fear)

Environmental (i.e. risks caused by environmental conditions such as falling trees, lightning, toxic chemicals, asbestos not risks to the environment)

Institutional (risks to the institution such as the school or agency. i.e. negative press, litigation)

What steps must be taken to reduce or eliminate the risk(s) and who is the responsible person to see that the risks have been minimized: (This active process must be clear to all)

Steps: Person Responsible:

What risks exist that cannot be eliminated? (and do these risks outweigh the benefits of the activity? If so, then the activity should not be held)

What steps specific to this activity are planned to be implemented in the event a risk becomes an emergency? (Don t forget to assign these specific steps to specific people)

(Source: The Service-Learning Initiative of Southwest Colorado)

TEACHER PREPARATION

Foxx and Hoard. Flowering Plants of the Southwestern Woodlands.1995

National Audubon Society, Richard Spellenberg. National Audubon Society Field Guide to North American Wildflowers: Western Region, National Audubon Society Field Guide. 2001

Pyne, Stephen J. & Cronon, William. Fire in America: A Cultural History of Wildland and Rural Fire.1997

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Pyne, Stephen J.,Andrews, P.L., & Laven, R.D. Introduction to Wildland Fire.1996

Thybony, Scott. Wildfire. 2002

Arrowood, Janet. Living With Wildfires: Prevention, Preparation, and Recovery.2003.

Bryan, Nichol. Los Alamos Wildfires. 2003

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Gilmer, Maureen. The Wildfire Survival Guide: Defensive Landscaping to Protect Your Family and Home Before, During and After a Wildfire.1995.

National Interagency Fire Center
http://www.nifc.gov

Bureau of Land Management
http://www.blm.gov

Discovery Channel School
http://discoveryschool.com

Fire Information Now Database United States Fire Administration/FEMA
http://www.usfa.fema.gov/find

Fire Management Today
http://www.fs.fed.us/fire/planning/firenote.htm

FireNet (International Fire Information Network)
http://online.anu.edu.au/Forestry/fire/firenet.htm

FireSafe
http://firesafe.org

FireWise
http://www.firewise.org

Index to Wildland Fire WWW catalog
http://www.blm.gov/narsc/wildfire/wwwindex.html

NASA Earth Observatory Global Fire Monitoring
http://earthobservatory.nasa.gov/Library/GlobalFire/fire.html

National Park Service
http://www.nps.gov

National Wildfire Coordinating Group (NWCG)
http://www.nwcg.gov

Smokey Bear s Official Homepage
http://www.smokeybear.com.

TEACHER PREPARATION

Southwest Area Wildland Fire Operations
http://www.fs.fed.us/r3/fire/

The Nature Conservancy National Fire Management Program
http://www.tncfire.org

U.S. Fish and Wildlife Service
http://ww.fws.gov

USDA Forest Service Fire Effects Information System
http://www.fs.fed.us/database/feis

USGS Wildland Fire Research
http://www.usgs.gov/themes/Wildfire/fire.html

ACKNOWLEDGEMENTS

This guide was written and field-tested by area teachers, naturalists, scientists, and members of the Volunteer Task Force.

Authors:
Laura Patterson, Mountain Elementary School teacher, Los Alamos, NM

Craig Martin, naturalist and writer, Volunteer Task Force, Los Alamos, NM

John Hogan, United States Geologic Survey ecologist, Volunteer Task Force, Los Alamos, NM

Teralene Foxx, fire ecologist and artist, Los Alamos, NM

Al Toth, retired police officer, teacher, Corpus Christi, TX

Special Thanks to:

Unit design:
Zina Jundi, Adverti-Zing, Santa Fe, NM

Project coordinator:
Lynne Dominy, Bandelier National Monument, NM

Artwork (drawn and copyrighted by):
Teralene Foxx and Dorothy Hoard

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Volunteer Task Force
3100 Arizona Avenue
Los Alamos, NM 87544
(505) 662-1612
E-mail: info@volunteertaskforce.org

Dear Parents:

Your child will be participating in a field trip with the Volunteer Task Force. Students will be participating in three activities that may include planting seedlings in the area burned by the Cerro Grande Fire, studying forest density and forest health, examining a stream profile, or distributing seed balls.

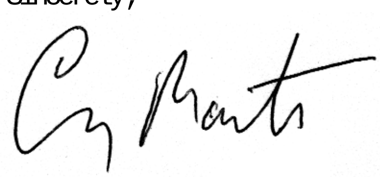
Students will be instructed on safe handling and use of tools, proper planting techniques, and the importance of community service. We will also discuss issues of forest health, fire ecology, and making better forests in the future.

In addition to signed permission slips, each student should bring the following required items:

Long-sleeve shirts
Long pants
Sturdy shoes
Work gloves
Hat
Sunscreen
Rain gear
Inhalers and other medicines, as appropriate
Water (at least a quart)
Snack

If you have any questions, please do not hesitate to contact your child s teacher or the Volunteer Task Force.

Sincerely,



Craig Martin
Project Manager

Field Trip Guidelines For Students

1. Be aware of the situation around you and your classmates; develop the habit of identifying hazards and then avoiding them. Examples: low branches, leaning trees. loose branches, loose stones, ledges and stump holes.

2. Pay attention to adults; follow instructions

3. Be prepared
   a. Have required materials
   b. Carry adequate water
   c. Bring lunch/snacks
   d. Wear appropriate footwear and clothing

4. Be responsible
   a. Carry trash back to school; dispose of properly
   b. Act appropriately
   c. Handle equipment with care
   d. Return all equipment and unused materials supplied to you in good condition

Agreement:
I fully understand and accept all rules and requirements governing conduct during the field trip. I understand that a violation or failure to meet these behavior standards will result in my removal from the trip. Any removal from a field trip for violation of safety rules will result in my not participating in future field trips.

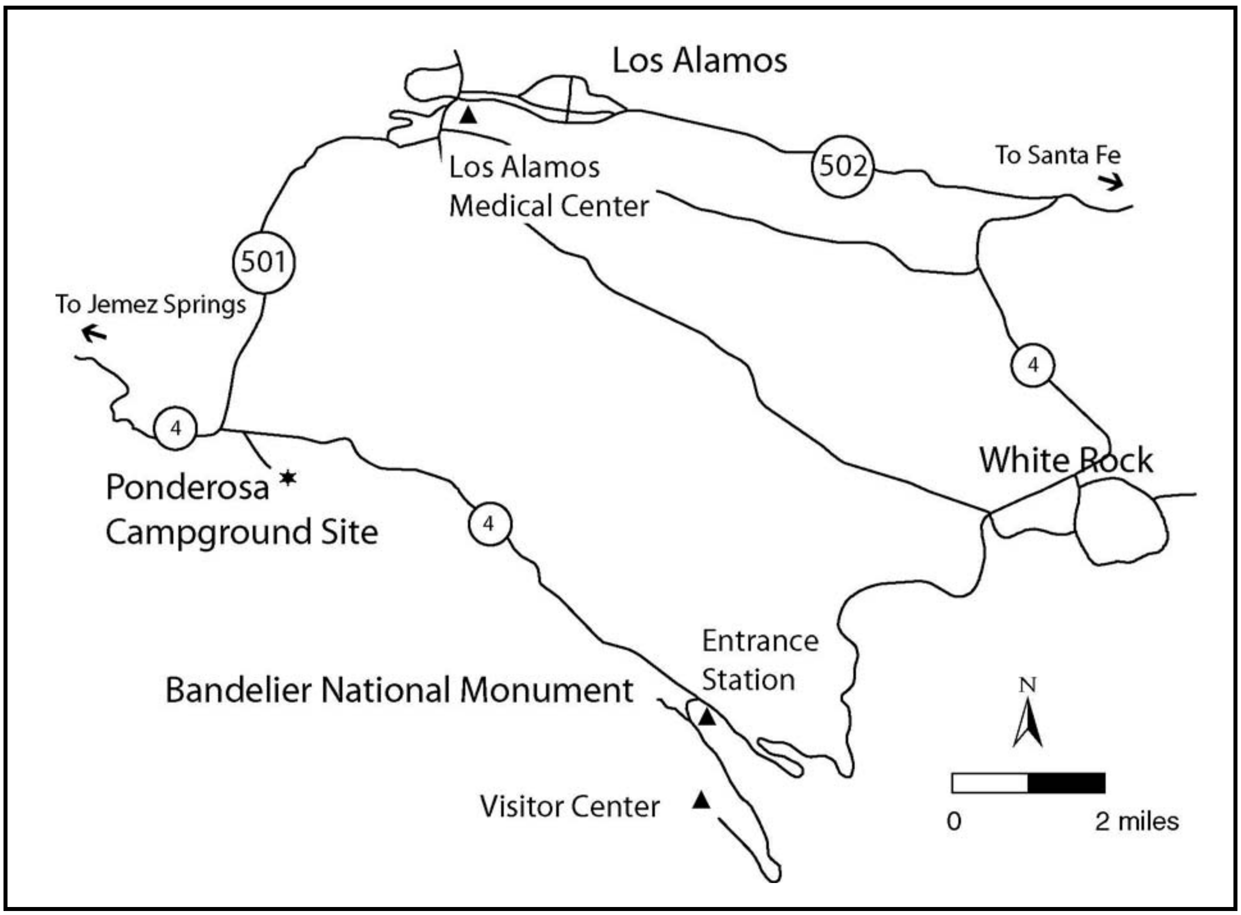
Student Signature		Date		Parent Signature

ATTACHMENT

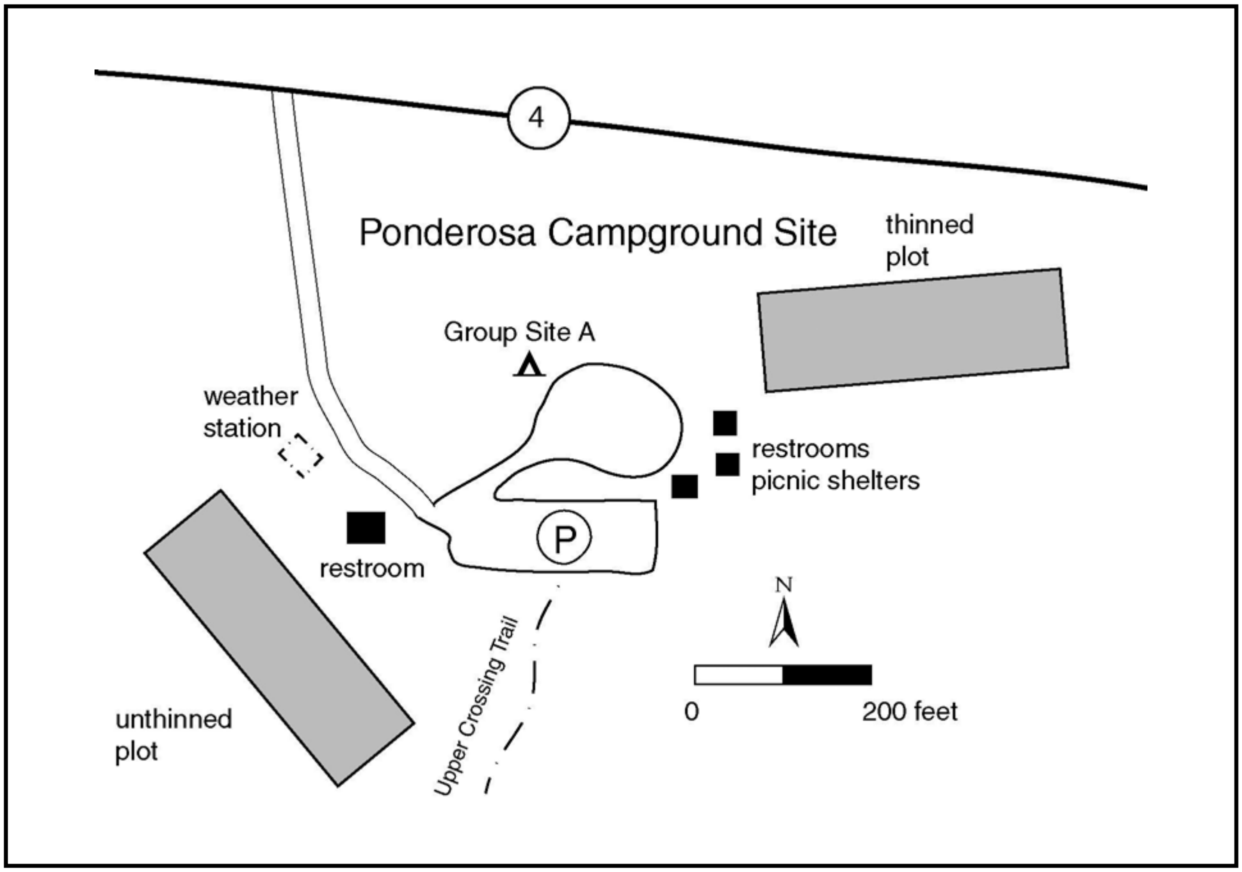
Ponderosa Campground at Bandelier National Monument

From Santa Fe, drive north on US Highway 84/285 about 15 miles to Pojoaque. Follow the exit signs for New Mexico Highway 502 and Los Alamos. Once on NM 502, continue 15 miles west to the interchange with New Mexico Highway 4. Bear right to get onto NM 4, following the arrows pointing toward White Rock and Bandelier National Monument. Continue on NM 4 through White Rock about 10 miles to the entrance to Bandelier National Monument. Continue straight on NM 4 past the entrance. In about 7 miles, Ponderosa Campground is on the left. Turn left into the parking area.

From downtown Los Alamos, drive west on Trinity Drive to the Los Alamos Medical Center. Turn left onto Diamond Drive, crossing the high bridge over Los Alamos Canyon. Just past the bridge, bear right onto New Mexico Highway 501. At a t-intersection in 4 miles, turn left onto New Mexico Highway 4. In 0.2 miles, turn right into Ponderosa Campground.



Ponderosa Campground Site Description
Sample plots are shown on the map below. Plots may be established in the general areas identified on the map but you must make sure that one of each is located in the thinned and unthinned areas.The thinned area (which has fewer trees) is located near the picnic shelters at Group Campsite A. Park either in the trailhead parking or in the parking circle for the group site. The unthinned area is across the gravel entrance road near the weather station. Look for the corner near the southwest corner of the fence surrounding the weather station.

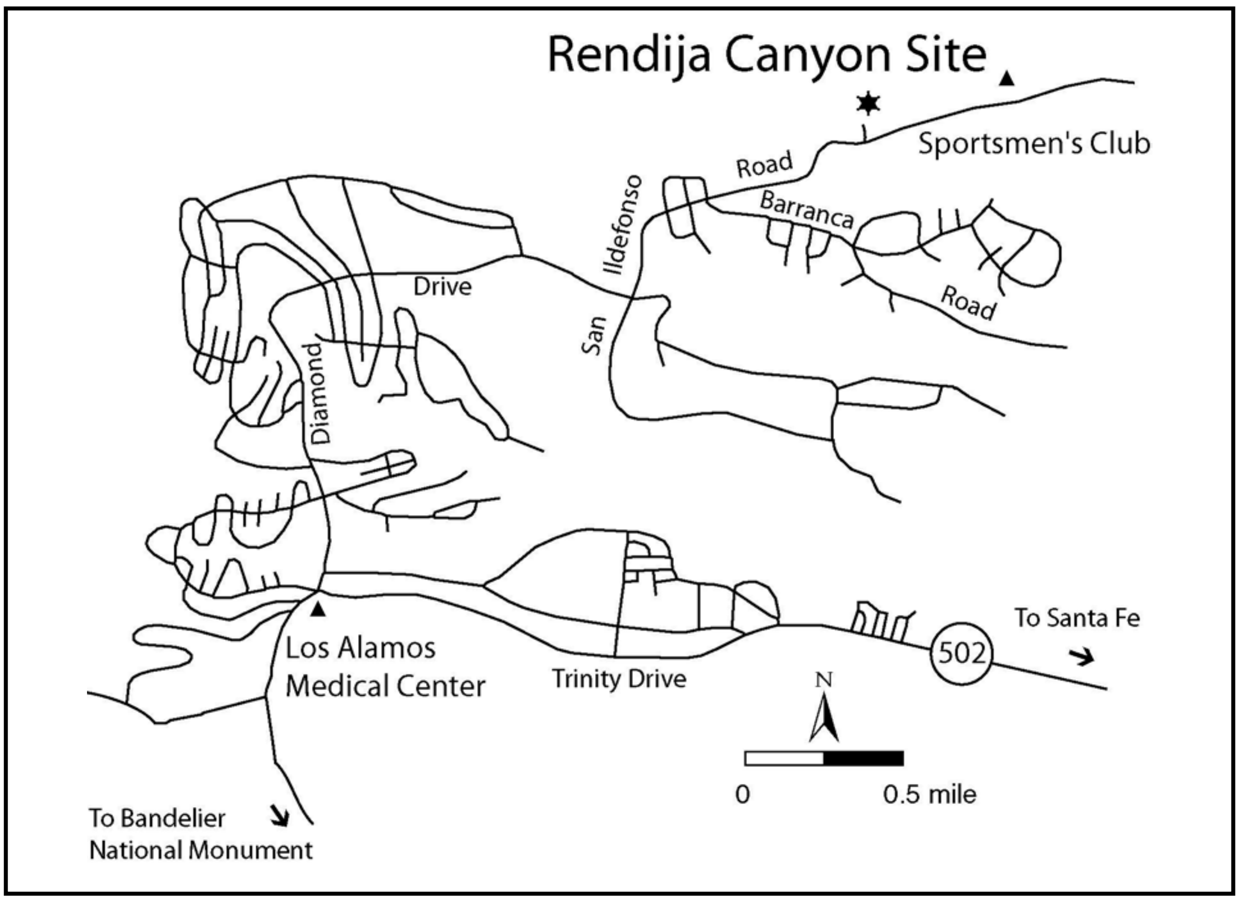


ATTACHMENT

Rendija Canyon, Santa Fe National Forest

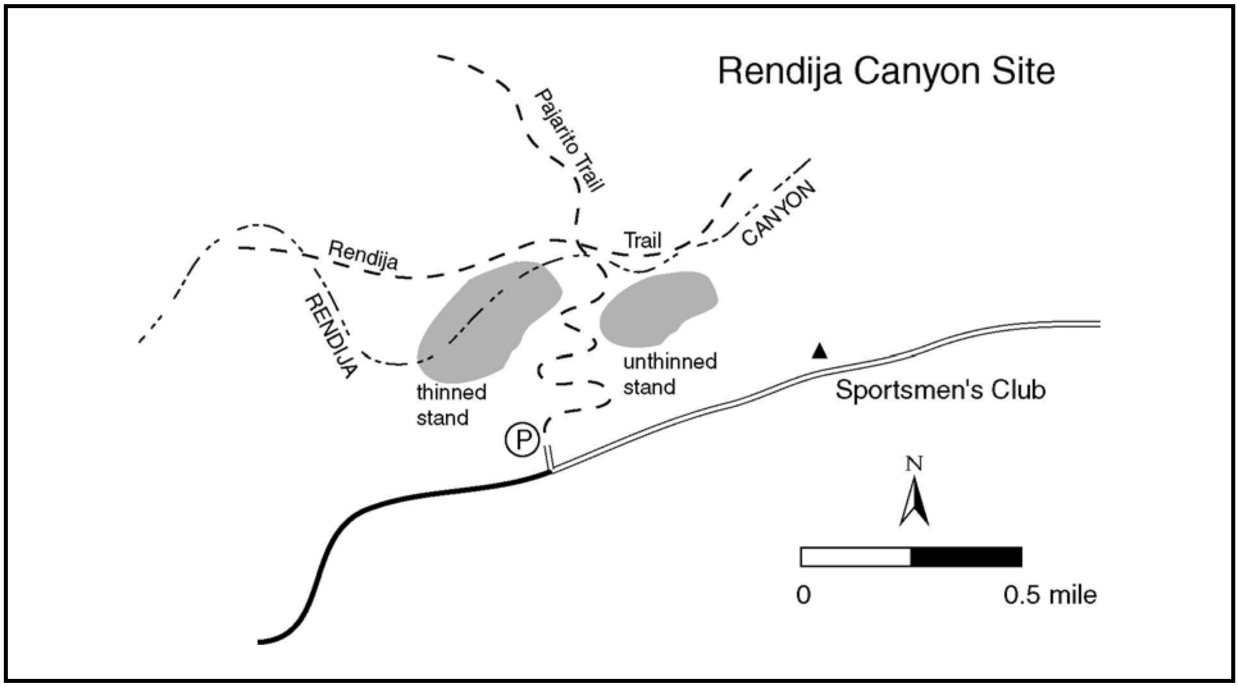
From Santa Fe, drive north on US Highway 84/285 about 15 miles to Pojoaque. Follow the exit signs for New Mexico Highway 502 and Los Alamos. Once on NM 502, continue 15 miles west to the interchange with New Mexico Highway 4. Continue straight on NM 502 toward Los Alamos. Stay on NM 502 as it becomes Trinity Drive in downtown Los Alamos. After about one mile on Trinity, turn right onto Diamond Drive at the Los Alamos Medical Center. Continue on Diamond Drive past the Los Alamos High School, around a bend, and past the golf course. Just past the golf course, swing around a traffic circle in the left hand lane. Scribe three-quarters of the circle to head uphill on San Ildefonso Road. In 0.4 miles, make a sharp left turn to stay on San Ildefonso Road. The road now drops steeply downhill. As the road begins to climb again, the pavement ends. Turn left at the end of the pavement and park in the dirt lot at the Pajarito Trailhead.

From downtown Los Alamos, drive west on Trinity Drive to the Los Alamos Medical Center.Turn right onto Diamond Drive at the Los Alamos Medical Center. Continue on Diamond Drive past the Los Alamos High School, around a bend, and past the golf course. Just past the golf course, swing around a traffic circle in the left hand lane. Scribe three-quarters of the circle to head uphill on San Ildefonso Road. In 0.4 miles, make a sharp left turn to stay on San Ildefonso Road. The road now drops steeply downhill. As the road begins to climb again, the pavement ends. Turn left at the end of the pavement and park in the dirt lot at the Pajarito Trailhead.



Site Description

From the trailhead for the Pajarito Trail, walk on the trail as it descends toward the bottom of Rendija Canyon on several switchbacks. Immediately before the trail crosses the arroyo in the canyon bottom, an unthinned stand of trees on flat ground lies to the right. Across the arroyo (west of the trail) is a large area that has been thinned and treated with prescribed fire.

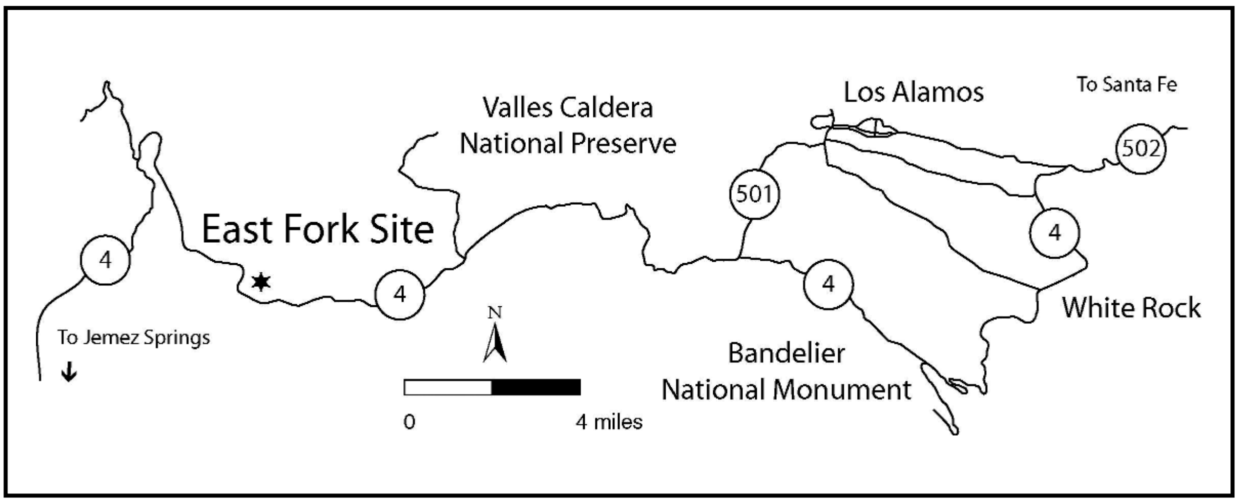


ATTACHMENT

East Fork Site, Santa Fe National Forest

From Santa Fe, drive north on US Highway 84/285 about 15 miles to Pojoaque. Follow the exit signs for New Mexico Highway 502 and Los Alamos. Once on NM 502, continue 15 miles west to the interchange with New Mexico Highway 4. Continue straight on NM 502 toward Los Alamos. Stay on NM 502 as it becomes Trinity Drive in downtown Los Alamos. After about one mile on Trinity, turn left onto Diamond Drive, crossing the high bridge over Los Alamos Canyon. Just past the bridge, bear right onto New Mexico Highway 501. At a t-intersection in 4 miles, turn right onto New Mexico Highway 4. Climb a steep hill. Continue 25 miles from the intersection with NM 501 to the East Fork Trailhead on the right.

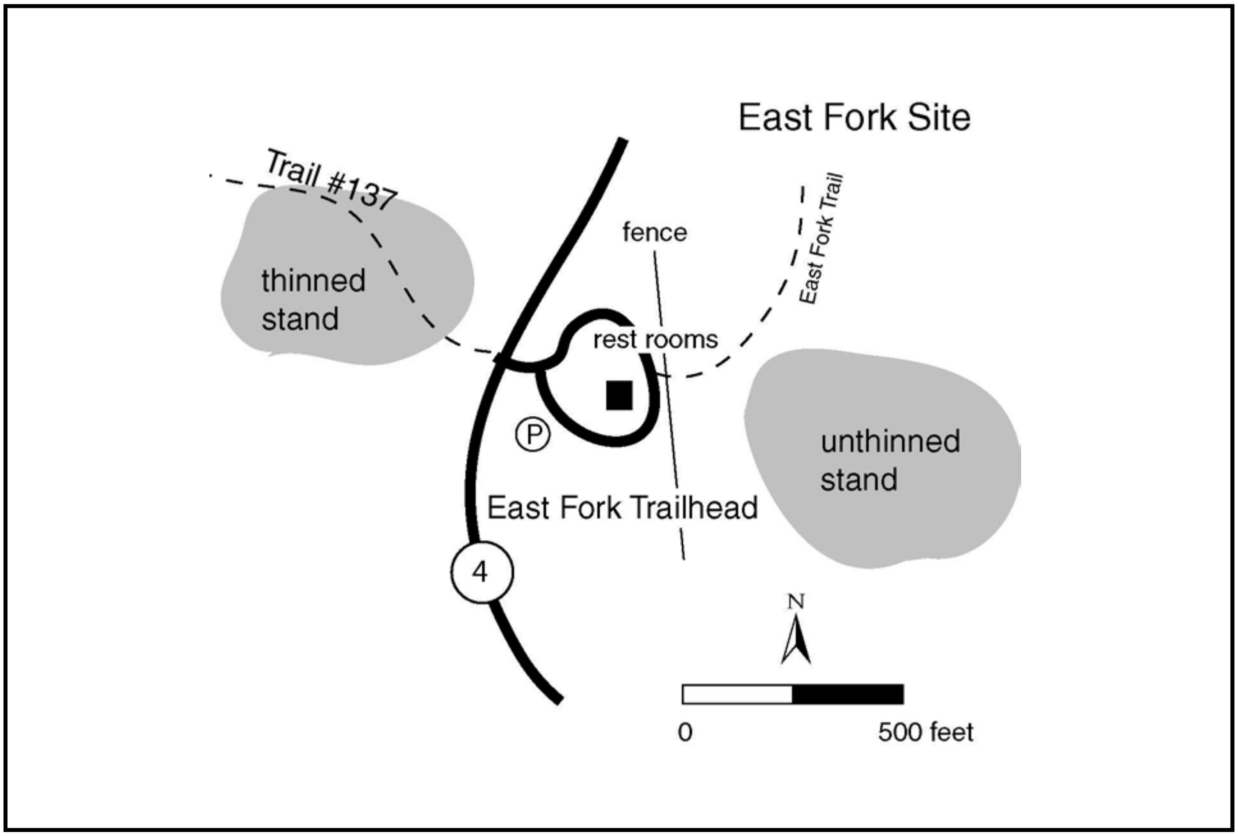
From downtown Los Alamos, drive west on Trinity Drive to the Los Alamos Medical Center. Turn left onto Diamond Drive, crossing the high bridge over Los Alamos Canyon. Just past the bridge, bear right onto New Mexico Highway 501. At a t-intersection in 4 miles, turn right onto New Mexico Highway 4. Climb a steep hill. Continue 25 miles from the intersection with NM 501 to the East Fork Trailhead on the right.



Site Description
From the parking area, the unthinned site is through the fence at the start of the East Fork Trail at the east side of the parking loop. Walk through the hiker s gate and continue uphill on the trail for a few yards. Unthinned forest on flat ground is to the right.

To reach the thinned site, use caution crossing the highway to reach the East Fork Trail #137 on the west side of the highway. Pass through a hiker s gate and enter a thinned stand of ponderosa pine. The stand to the right of the trail makes a good area for a plot.

ATTACHMENT



Risk Management Planning

Describe the proposed activity:

List the goals and anticipated outcomes:

Who is responsible for instructing the students about the activity, safety, risks involved and risk management plans?

What risk does this activity present?

Physical

Emotional/psychological

Environmental

Institutional

What steps must be taken to reduce or eliminate the risk(s) and who is the responsible person to see that the risks have been minimized:

Steps:
Person Responsible:

What risks exist that cannot be eliminated?

What steps specific to this activity are planned to be implemented in the event a risk becomes an emergency?

(Source: The Service-Learning Initiative of Southwest Colorado)

Proposal for Field Trip Approval

School: ______________________ Proposal Date: ______________________

Principal: ____

Teacher
Organizer(s): ____

Destination: ____

Field trip date(s): ____

Departure and return times: ____

Field trip description: (brief)

____

____

Grade Level: ____

Number of students: ____

Number of teachers: ____

Number of chaperones: ____

Mode of transportation: ____

Financial costs and arrangements ____

Alternate educational plans for students not attending the field trip:

____

____

____

____

____

____

Principal s Signature for Approval

Notes:

____

____

____

____

CONSENT AND RELEASE FORM FOR INTERVIEW, PHOTOGRAPHING, VIDEOTAPING AND/OR WEBSITE USE

I consent to interview(s), photography, videotaping and its/their release, publication, exhibition, or reproduction to be used for public relations, news articles or telecasts, education, research, inclusion on the Volunteer Task Force Website, fund raising, or any other purpose by the VTF and/or its affiliates. I release the VTF, their board members, and each and all persons involved from any liability connected with the taking, recording, or publication of said interviews, photographs, slides, computer images, videotapes, or sound recordings.

I waive all rights I may have to any claims for payment or royalties in connection with any exhibition, televising, or other publication of these materials, regardless of the purpose or sponsoring of such exhibiting, broadcasting, or other publication irrespective of whether a fee for admission or film rental is charged. I also waive any right to inspect or approve any photo, video, or film taken by the VTF or the person or entity designated by it. I release and discharge the VTF from any liability by virtue of any blurring, distortion, alteration, optical illusion, or use in composite form whether intentional or otherwise, that may occur or be produced in the taking of the pictures, or in any processing toward the completion of the finished product. All negatives and positives, whether prints, video, film, or sound recording are the property of the VTF or the person or entity designated by it, solely and completely.

I declare that if I am under the age of eighteen (18) years old I have acquired the written consent of my parent or guardian. I understand that the terms herein are contractual and not a mere recital, that this instrument is legally binding, and that I have voluntarily signed this document.

I have fully informed myself of this consent, waiver of liability, and release before signing it.

Student s Name (please print) ____ Date ____________________

Student s Address ___________________________________ Phone __________________________________

Signature of Student ____

If student is under 18, the parent or legal guardian, if any, must sign.

Parent/Guardian Name (please print) ________________________________ Phone ____________________

Signature of Parent/Guardian ____ Date ____________________

Witness Signature ____

Witness Name (please print) ____

List anticipated uses, i.e. brochure, display board, website, etc.

Return signed form to: The Volunteer Task Force, 465 Grand Canyon Dr. Los Alamos, NM 87544

PROGRAM EVALUATION FORM

The Volunteer Task Force and National Park Service wish to provide you and your students with the best program possible. The few minutes it will take to complete this evaluation will provide invaluable information for the education staff. Thank you for your time and thoughtful response.

Please fill out the following information:

Teacher Name ______________________________

E-mail Address ______________________________

School Name ______________________________

School Address ______________________________

School Phone (include area code) ______________________________

Home Phone ______________________________

Grade Level ______________________________

Number of Students ______________________________

Location where activity took place ______________________________

Date of Visit ______________________________

1. How would you rate the overall quality of the educational program your students participated in today?

❏ Excellent
❏ Good
❏ Fair
❏ Poor

Comments ______________________________

____

2. How would you rate the educational content presented in the program?

❏ Excellent
❏ Good
❏ Fair
❏ Poor

Comments ______________________________

____

3. How would you rate the presenter s instructional skills?

- ❑ Excellent
- ❑ Good
- ❑ Fair
- ❑ Poor

Comments ____

____

4. Did you receive the proper pre- and post-visit materials (if applicable)?

- ❑ Yes
- ❑ No
- ❑ Not applicable

Comments ____

____

5. Which lessons were the most effective?

____

____

____

____

6. Was the program appropriate for the maturity level of your student s?

- ❑ Excellent
- ❑ Good
- ❑ Fair
- ❑ Poor
- ❑ Unable to judge

Comments ____

____

7. Would you recommend this program to other teachers?

- ❑ Yes
- ❑ No
- ❑ Undecided

Comments ____

____

8. What could the VTF or NPS do to improve your education program? ____________

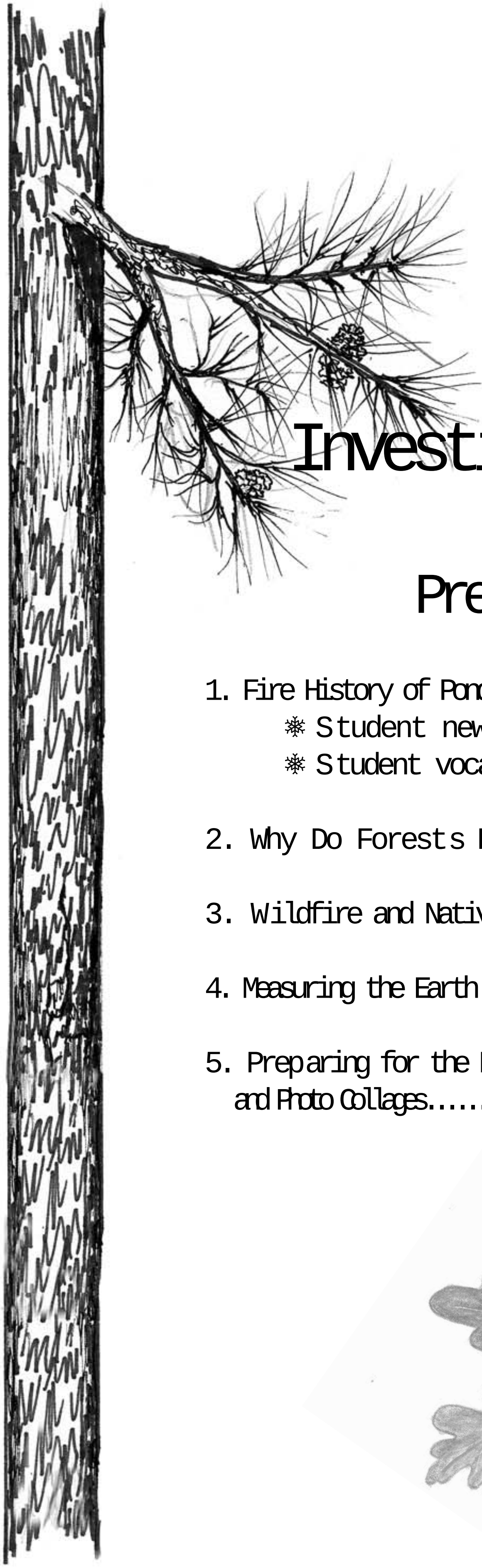
____

____

____

____

____



Investigating Fire Ecology

Pre-Field Trip Lessons

FIRE HISTORY OF PONDEROSA PINE ECOSYSTEMS

FOCUS QUESTIONS:
Why do foresters and ecologists think many ponderosa pine forests are unhealthy?

What role does fire play in the ponderosa pine ecosystem?

OVERVIEW OF LESSON: This lesson provides students with the basic knowledge and vocabulary they need to begin their study of fire ecology in ponderosa pine forests. Students can use a variety of source materials to learn about how forests, and the fires that burn through them, have changed over the last century. Students will read background material in a fire ecology newspaper, and can watch a presentation about fire from the internet. An evaluation will allow teachers determine if students have the background knowledge to continue with the lesson sequence.

SUGGESTED TIME ALLOWANCE: Class Time: 2 hours

LOCATION: Classroom

SUBJECT AREAS: Science, Math, Technology

STUDENT OBJECTIVES

Students will:

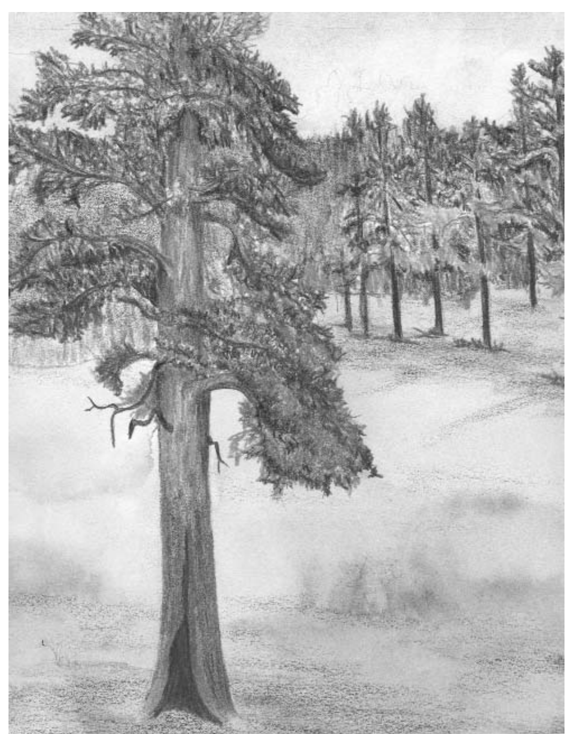
- Identify the basic components of the ponderosa pine ecosystem
- Understand how current forests differ from forests of 100 years ago
- Learn the importance of fire to the balance within the ecosystem

VOCABULARY

- Crown fire
- Cambium
- Fire behavior
- Tree rings
- Surface fire
- Fire suppression

MATERIALS

- Field journals
- Pencils
- Flip chart paper/blackboard
- Pre- and Post evaluation activity sheets
- Investigating Fire Ecology newspaper



PROCEDURES

Pre- and Post-evaluation

Distribute the pre- and post-evaluation activity sheets. Remind students that this is not a graded test, but rather a measure of success for the lesson. Each student will retake the test at the end of the lesson.

1. As a class, have students brainstorm a list of what makes a healthy forest and what makes an unhealthy forest.

2. Divide students in groups of three or four, assigning each group the following questions:
   a. When wildfire strikes, why do some trees live and others die?

   b. What happened in the late 1800 s that contributed to crowded forest conditions?

   c. How has the local ponderosa pine forest ecosystem changed over the past century?

   d. What differences do you think you will observe in a thinned plot and an unthinned plot?

3. Hand-out copies of the enclosed newspaper and vocabulary lists to each student. Have each student read the newspaper and answer their question as a group.

4. Resume whole class discussion. Have each group do a presentation on their answers to their question.

5. Invite a local ecologist to the classroom to discuss ponderosa pine fire ecology or view the presentation on fire ecology at: www.volunteertaskforce.org/lessons

Name ____

Fire History of Ponderosa Pine Ecosystems
Assessment Questions

STUDENT SHEET

1. What information can be determined about tree growth from analyzing tree rings?

2. The only part of a tree that is actually alive is a very thin layer directly under the bark called the ____________________.

3. During good growing conditions, annual growth tree rings will be ________________.

4. In years of less favorable growing conditions, annual growth tree rings will be ______________________.

5. Ponderosa pine forests have evolved over thousands of years. What are some of the adaptations this tree has developed which have helped its survival rate?

6. Before European settlement, widespread fires occurred every 2-15 years. If you were an early explorer how would you describe the condition of the forests in the early 1800 s?

7. What is fire suppression and how has it contributed to the fuel buildup on the forest floor?

8. Today s forests are often characterized by dense dog-hair thickets of young pine. Explain what this term means.

9. The three things that affect fire behavior are:
   1.______________
   2.______________
   3.______________

10. Many ponderosa pine forests today have become dense, unhealthy thickets of young trees and needle litter mats. What triggered this change in the forest structure? When did this happen? How has this change contributed to destructive forest fires?

11. New Mexico has the second highest incidence of lightning strikes. What state is the highest?

12. What are some ways we can restore the ponderosa pine forests of the region to a more natural state?

Fire History of Ponderosa Pine Ecosystems
Assessment Teacher Master Sheet

TEACHER MASTER

1. What information can be determined about tree growth from analyzing tree rings?

Tree rings can tell how old a tree is and the story of its growth. Widely spaced rings indicate favorable climate conditions when the tree grew much in a year. Closely packed rings indicate drought conditions or increased competition with other vegetation.

2. The only part of a tree that is actually alive is a very thin layer directly under the bark called the cambium.

3. During good growing conditions, annual growth tree rings will be wide apart.

4. In years of less favorable growing conditions, annual growth tree rings will be close together.

5. Ponderosa pine forests have evolved over thousands of years. What are some of the adaptations this tree has developed which have helped its survival rate?

Thick bark protects the cambium from low intensity fires.
Lower branches of ponderosa pine are shed to prevent small fires from reaching the needles. This is called self-pruning.

6. Before European settlement, widespread fires occurred every 2-15 years in this area. If you were an early explorer how would you describe the condition of the forests in the early 1800 s?

Forests were open and park-like. Ponderosa pines were widely spaced at a density of between 50 and 150 trees per acre. The ground was covered with tall grasses and many species of wildflowers.

7. What is fire suppression and how has it contributed to the fuel buildup on the forest floor?

Fire suppression is the attempt to extinguish all fires as quickly as possible before they have a chance to spread. Because downed and dead trees, needles and leaves, and other forest litter was not periodically burned, the elimination of fire from ecosystems has resulted in a huge increase in the fuel available to fires on the forest floor.

8. Today s forests are often characterized by dense dog-hair thickets of young pine. Explain what this term means.

Dog hair thickets are stands of small-diameter pines with densities of hundreds or even thousands of trees per acre.

9. The three things that affect fire behavior are:

1. fuel
2. weather
3. topography

10. Many ponderosa pine forests today have become dense, unhealthy thickets of young trees and needle litter mats. What triggered this change in the forest structure? When did this happen? How has this change contributed to destructive forest fires?

Fire suppression played a role in the fuel buildup. Also, grazing patterns in the late 19th and early 20th centuries contributed through large numbers of grazing livestock eating the grassy fuels that once carried low-intensity wildfires through the forest. Livestock grazing patterns changed around 1880 and fire suppression became a factor in about 1910.

11. New Mexico has the second highest incidence of lightning strikes. What state is the highest?

Florida

12. What are some ways we can restore the ponderosa pine forests of the region to a more natural state?

Forests can be mechanically thinned. Once the forest is in a condition that reduces the threat of crown fire, prescribed fires can be introduced.

Fire Ecology

In Ponderosa Pine Forests of the Jemez Mountains

Fire s Place in Ponderosa Pine Forests

Hills covered with ponderosa pine forest are the reason many of us choose to live in the mountains of the Southwest. For millennia, these forests have been maintained by frequent, low-intensity surface fires. But many of the forests that we love are unhealthy, overgrown, and ripe for a devastating crown fire. Between 1996 and 2003, 40,704 wildfires burned 3,152,770 acres of forest in New Mexico and Arizona, enough burned forest to cover the entire state of Connecticut.

By living through the Cerro Grande fire, tis aftermath, and the long process of recovery of the forest ecosystem, those of us who live in Los Alamos have a vast pool of knowledge that should be shared with other fire-affected communities around the West. Hundreds of towns and cities within ponderosa pine forests experience the same pre-fire conditions that existed here and, unfortunately, some of these communities will experience wildfire.

Everyone who lives in or near ponderosa pine forests needs to know the role that fire plays in the ecosystem. Studying fire ecology will help you understand how ponderosa pine forests are managed and why it is important to maintain healthy forests. It will give you the knowledge that when used properly, prescribed fire is an essential management tool to keep forests in good condition.

Understanding fire ecology can help you make your home so that it can be defended against a wildfire. To live in ponderosa pine forests, we must accept fire as part of our environment and manage our lands and build our homes accordingly.

W ritten by the Volunteer Task Force

What s Inside q

Craig Martin

Fire in the Pines

Cerro Grande. Rodeo-Chediski. Missionary Ridge. Aspen. Since May 2000 raging wildfires have burned through immense expanses of forests in New Mexico, Arizona, and Colorado. Along with dozens of smaller fires, these well-known examples burned mostly through ponderosa pine forest. Each burned as a crown fire, which is a devastating wave of flame that can reach 200-feet or more in height.

The ponderosa pine ecosystem-a unique collection of plants and animals centered on this stately pine species-is widespread throughout western North America, and particularly in the Southwest. Fire has always been a part of the ponderosa pine ecosystem, but the fires of the first years of the 21st century were radically different then fires of the past. Small, low-intensity fires that stayed low to the ground have been replaced by huge crown fires.

The forest itself is very much changed. Historic photographs from the late 1800s show

Fire climbs from the forest floor into the tree canopy creating a raging crown fire.

Forests of the late 1800 s (left) were much more open and grassy than the densely crowded forests found in many places today (right).

very different ponderosa pine forests than that found in the Southwest today. Photos show these forests as extensive grasslands dotted with small clusters of ponderosa pines. In some scenes the grasses are two or even three-feet high; the orange-barked trees reach 200 feet into the sky.These forests had an open forest structure with individual trees or small clumps of trees spaced widely apat. The forest held between 50 and 150 trees per acre. Today the forests have far many more trees.

We came to a glorious forest of lofty pines, through which we have traveled ten miles. The country was beautifully undulating; and although we usually associate the idea of barrenness with pine regions that was not so in this sense: every foot being covered with finest grass and beautifully grassy glades extending in every direction The forest was perfectly open and unencumbered with brush wood so that traveling was excellent.

Edward Beale, Railroad surveyor
Describing the forest when he passed through Arizona in 1858

Ponderosa Pine Basics

Ponderosa pine (Pinus ponderosa) is the most common and widespread pine in North America. It grows from the dry mountains of central Mexico north to the Rocky Mountains of Canada, and from Nebraska to the Pacific Ocean. The largest ponderosa forests are found in northern New Mexico and along the Mogollon Rim in central Arizona. In the Southwest, ponderosa pines grow from about 6,000 8,500 feet in elevation. As the climate warmed at the end of the last ice age, ponderosa forests developed in the southwest about 8,000 to 9,000 years ago. The ponderosa grows in dry climates and is found in locations that receive as little as 7 inches of rain per year.

Distribution of ponderosa pines in the West

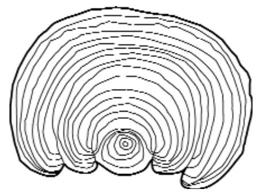
The variety of ponderosa pine in the Southwest usually has needles in bundles of 3. The needles are 4-8 inches long, the longest of any conifer (cone-bearing tree) in the region. On young trees, the bark is grey or black. Once a ponderosa pine reaches about 75 years old, the bark turns orange and cracks into ovals that look like giant lizard scales. When warmed in the sunlight, the orange bark smells like vanilla! The cones are round and heavy, with all the scales tipped with a sharp point. The seeds in the cones are an important food source for all seed-eating animals in the forest, particularly squirrels. Depending on local conditions, a ponderosa pine can grow to be 150 feet tall and up to 4 feet in diameter. The tree can live 400 to 500 years.

Ponderosa pine is a fire-adapted species. These trees have bark up to 4 inches thick to protect the tender growing tissue beneath. Ponderosas have long needles that help protect the growing branch tips against heat from a fire. As they grow tall, these trees lose their lower branches in a process called self-pruning. This increases the chance of a tree to survive a surface fire by taking away the fuel a fire could burn so that the flames can t reach into the crown of the tree. The root system is deep under the ground, offering the roots protection from fire.

Ponderosa Pine Fire Ecology

Fire is a keystone ecological process in ponderosa pine forests of the Southwest. Fire was a major factor in shaping the appearance and characteristics of these forests. Fire also serves to maintain the forests and keep them functioning as a healthy ecosystem.

Ecologists can learn much about the history of an individual tree or an entire forest by studying tree rings.



As a tree grows, it adds rings of cells to the outside of the trunk. Each year, a light ring of spring cells is added before a darker ring of fall cells. By counting either the light or dark rings, anyone can estimate the age of a tree.

A low intensity surface fire that burns mostly grasses can damage a ponderosa pine without killing the tree. During a small fire, flames can wrap around the base of a tree trunk, eat away the bark, and damage the cambium, the growing layer of cells of the tree. Just like with an injury to human skin, scar tissue forms over the wound. That section of the tree trunk may never grow again. The shape of the tree at the base changes from a circle to a C. The result is called a cat-face scar. In the tree rings, the scar tissue remains as a dark line that interrupts the normal pattern.

By studying tree rings and fire scars, ecologists have found that prior to 1890, ponderosa pine forests had the highest fire frequency of all forest types found in the Jemez Mountains. Frequent, low-intensity surface fires burned through the grassy understory of these forests about every 7-10 years. These fires, mostly caused by lightning, kept the forest open by thinning out some of the seedlings. These fires also recycled important nutrients. Tree rings tell a similar story in other parts of the Southwest such as along the Mogollon Rim in Arizona, near Flagstaff, and in the pine forests of southern Colorado.

Then around 1890, throughout the Southwest the fires just stopped. This was due to the combined effects of overgrazing by livestock, fire suppression, logging, and the highly variable southwestern climate. Grazing animals, especially sheep, ate the grass that once carried small fires through the forest.

Starting around 1910, an effort was made to put out all fires that started in the forest. Lumber companies took many of the old ponderosa pines from the forests, allowing more seedlings to sprout in the sunlight. Also, periods with large amounts of rain and snow allowed more trees to grow. Without the low-intensity surfaces fires, forests became much denser. Some of our ponderosa pine forests now have several thousand trees per acre! These stands are called dog-hair thickets.

Dense stands of ponderosa pines are very different places than the wide open forests of one hundred years ago. Because the tree canopy - the upper layers of branches on the trees - is so dense, little sunlight reaches the forest floor. Few grasses or wildflowers can grow in deep shade. Also, many pine needles fall from the trees each year. In the past, fire periodically cleaned up the layer of needles and released nutrients into the soil. Without fire, needles can accumulate to depths over one foot. This makes it difficult for seeds to germinate and disrupts some nutrient cycles in the forest. The result is a forest with very few types of plants growing there. Species diversity is low in a dog-hair thicket.

Trees such as Douglas fir grow well in the shade. Inside some dense stands of pines, Douglas firs grow as small and mid-sized trees. During a small fire, young Douglas firs can provide a path for fire to carry from surface fuels into the crowns of ponderosa pines. Plants that allow fire to move into the crowns of the tallest trees are called ladder fuels.

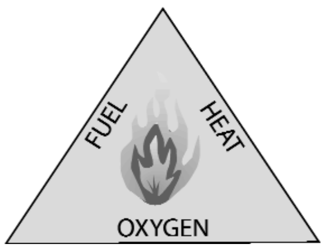
Dense stands of trees, a thick pile of needles on the forest floor, an accumulation of logs and branches from dead trees, and ladder fuels are the recipe for destructive crown fires. When a hot fire reaches toward the needles of ponderosa pines, the heat releases flammable chemicals from the needles. Trees can literally explode, and the sudden increase in heat and flame pushes the wildfire into nearby trees. Crown fires are carried rapidly through ponderosa pine forests.

The important role that fire plays in the ponderosa pine ecosystem is not unique, but ecosystems dominated by other species of conifer respond to fire in different ways. In some ecosystems, such as high elevation forests in the Southwest, crown fires are the natural way they burn. Small, patchy crown fires may burn sections of this forest every 150 to 200 years. Each forest type should be managed according to the specific role fire plays there.

Factors of Fire Behavior

The Fire Triangle and Forests

Fire is a simple chemical reaction that requires three components: heat, oxygen, and fuel. Remove any of the components and you no longer have fire. Each component supports the others in the fire triangle. This is true for something as small as a burning candle or as large as a raging wildfire.



Heat in a Wildfire: Why Fires Start

When enough heat is applied to fuel with oxygen present, fire can start. Before people came to ponderosa pine forests, the heat that started wildfires came mainly from lightning. The number of lightning strikes in the Southwest, particularly in the Jemez Mountains, is higher than in any other part of the United States except southern Florida.

When people arrived in the ponderosa pine forest, they used fire on the landscapes. As a result, even more fires occurred in the forest. Campfires sometimes burned into the forest, and sometimes people lit fires to chase game animals out of the forest so that it was easier to hunt. Later, fires were lit to improve grass conditions for grazing cattle or sheep. Today, unintentional sources of wildfire include sparks from vehicles and trash burning.

The temperature of the air and the ground can affect how easy it is to start a fire. High summer temperatures increase the chance of a wildfire start.

Fuel for Thought: What in the Forest Can Burn?

Many parts of the forest can serve as fuel for a fire. Forest fuels include logs, dried grasses, pine needles, and if the fire has enough heat, the crowns of living trees. Fuels are divided into two groups that are based on the way they burn during a fire.

Light fuels ignite fast because they are surrounded by oxygen in the air. They have a small diameter, so it takes less heat to start them burning. Examples of light fuels are dried grasses, dead leaves, dead pine needles, brush, and small trees. Fires in light fuels spread faster and burn cooler than fires in heavy fuels. Heavy fuels require more heat to ignite. However, after they start burning, heavy fuels gives off much heat and burn longer than light fuels. This is due to the fact that heavy fuels burn more slowly than light fuels. The outside layers take longer to burn off before oxygen can reach the inner material. Examples of heavy fuels are logs, stumps, tree branches, deep duff or decayed leaves, and other organic materials.

Oxygen on the Wind

Oxygen is always present in the forest, but certain conditions can add more oxygen to a fire. The harder the wind blows, the faster a fire spreads. Wind not only provides oxygen for the fire, but it also blows the heat and flames toward unburned fuel. As the unburned fuel becomes preheated, it ignites quickly and helps to spread the fire farther. Wind extends fire rapidly into unburned areas. As the wind carries embers over long distances, new fires may ignite.

Other Considerations

In the forest, the supply of the three components can determine the severity of a wildfire. A dense forest offers more fuel; a windy day provides a constant supply of oxygen. How fuels ignite, flames develop, and fire spreads is called fire behavior. Fire behavior is determined by three major factors:

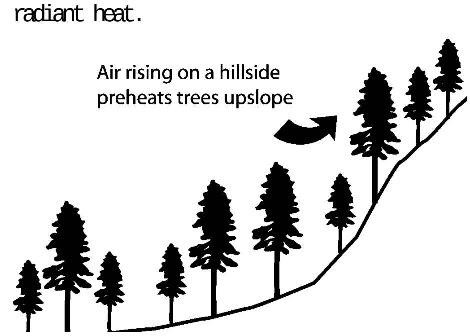
- The amount and type of fuels present
- The existing weather conditions
- The elevation and slope of the area (topography)

Fuel composition, including moisture level, chemical makeup, and density, determines its degree of flammability. Moisture level is most important. Live trees usually contain a great deal of moisture while dead logs contain very little. The moisture content and distribution of these fuels define how quickly a fire can spread and how intense or hot a fire may become. High moisture content will slow the burning process since heat from the fire must first eliminate moisture. In addition to moisture, a fuel's chemical makeup determines how readily it will burn. Some plants, such as ponderosa pines, have high concentrations of volatile compounds in their needles. Once exposed to flame, these compounds, called terpenes, can burst into flame with explosive force. Finally, density of fuel beds influence its flammability. If fuel particles are close together, they will burn readily. But, if fuel particles are so close that air cannot circulate easily, the fuel will not burn freely. Weather conditions such as wind, temperature, and humidity contribute to fire behavior. Wind, a most important factor, brings a fresh supply of oxygen to the fire as well as pushes the fire toward new fuel sources.

Temperature of fuels is determined by the surrounding air temperature since fuels initially attain their heat from the sun. As fire burns, high heat from nearby fires preheats fuels around the perimeter of the fire, sometimes to the point that they burst into flames without being touched by advancing flames.

Humidity, the amount of water vapor in the air, affects the moisture level of a fuel. At low humidity levels, fuels become dry, catch fire more easily, and burn more quickly than when humidity levels are high.

The shape of the land, which is called its topography, plays a critical role in how a wildfire burns. On flat land, fires usually burn more slowly than on slopes. This is because on slopes, heat rises from trees burning at the base of the mountain and preheats the trees that grow above. This transmits heat quickly to overhanging branches and other elevated fuels. At the same time, radiant heat is transferred from the fire to other objects on the ground. Convection plays a critical role in spreading fires rapidly upslope. A steep slope draws fire upward by convection, and fire spreads rapidly as convective heat preheats fuels upslope. In contrast, fire travels slowly on flat terrain because ground-level fuels are only preheated by radiant heat.



Newspaper written by: Craig Martin
Designed by: Lynne Dominy

Is This Forest Healthy?

Sampling the Forest

A trained forester can make observations about a forest and determine if it is healthy or fire prone. However, even professionals can make better decisions when they make quantitative rather then qualitative observations. But how do we measure the forest?

One measure of forest health is the density of trees within an area. Before 1880, a typical acre of ponderosa pine forest held 50 to 100 trees. Using that number as a guide, researchers today can use the number of trees per acre as an important indicator of forest conditions.

We can't travel into the past to study forest conditions in the 1800s. But throughout the Southwest, forest managers have used modern techniques to backtrack through time and change forest conditions to something more like those in the past.

We can use thinned and unthinned stands of ponderosa pine to make a comparison between pre-settlement and modern forests and to evaluate the health of the present forest. One such stand is located just outside of Los Alamos in Rendija Canyon. The stand was thinned in 1996 and presents a picture of an open forest much like those of the last centuries.

Ecologists can't count the number of trees in an entire forest, and even an acre of forest can be too large to study. To make measurements easier while keeping them accurate, ecologists use a study plot to sample the forest. A plot is a small area you measure to estimate conditions in a large area that is too big to study. For example, to find the percent of surviving pine seedlings planted after a fire, you couldn't count all the dead and surviving seedlings on 600 acres. But it would be possible to set up several one-tenth-acre plots and from what you learn to estimate the survival rate of the whole planted area.

Researchers can use a plot sample to calculate tree density. They simply count all the trees in the plot and multiply the count by the size of the plot. For example, in a quarter-acre plot, multiply the number of trees by four. If the plot is one-quarter of one-quarter acre, then multiply the count by 16.

The size and age of the trees in forests can also indicate something about forest health. (To standardize the diameter measurements in the field, foresters measure trees about four feet above the ground or at chest height. The number is called the DBH.) In a dog hair thicket, trees grow close together. Closely spaced trees must compete with each other for water, nutrients in the soil, and for sunlight. Not many trees get all they need to grow. The result is slow growth. This can create a forest of old trees that have small diameters. By drastically reducing competition among the crowded trees, a thinning project releases a burst of growth in the remaining trees. The result is a rapid increase in the size of the trees.

When ecologists measure tree diameters, they can calculate the tree basal area of a stand. Tree basal area is the area of the plot covered by tree trunks. In unthinned plots, there are lots of small diameter trees; in a thinned plot, there are fewer but bigger trees. The total basal area of two plots such plots can be surprisingly similar.

The two pieces of information about the understory show the effects of the thick accumulation of pine needles when fire is removed from the system, and the effects of a closed canopy that reduces the amount of sunlight on the forest floor. Both the per cent cover and the biodiversity are increased when a forest is thinned and the canopy opened up. Biodiversity is a strong indicator of forest health.

WHY ARE SO MANY TREES DEAD?

Drought hit the Bandelier area with a vengeance in 2002. Ponderosa and piñon pines are showing signs of significant mortality brought on by the lack of rain and the corresponding invasion of pine beetles that attacked the weakened trees. 95% of the trees across some parts of the Pajarito Plateau died by the summer of 2003. Because of the increased fire danger posed specifically by the ponderosas, Bandelier Fire Crews have been working to build fire breaks and to remove bug-killed trees in critical areas. Many of the trees were piled and burned to destroy the beetle larvae and diminish the number that will become adults.

Safety in a Burned Area

Many dangers are found in a burned area for years after a wildfire passes through. Visitors to burned areas should always remember to be watchful for hazards: Always look up, look down, look all around.

Hazard Trees: Hazard trees are trees that could fall over and injure someone in the area. Hazard trees can be ones that are leaning, have fallen part way down and are resting on another tree. They can be trees obviously weakened by the fire at the base of the trunk, have vertical splits or cracks, broken or loose limbs, or a loosened and damaged root system. As you walk through a burned area, always try to identify hazard trees and to avoid walking near them. Stay out of burned areas on windy days.

Root Holes: A wildfire can burn the roots of trees and stumps-even though they are underground. When the wood is burned, it leaves a hole in the ground. These holes are often covered with soil and not visible on the surface. If you step on a root hole, the ground above can collapse. Always watch for root holes when traveling in a burned area.

Rolling Objects: After a wildfire there is little vegetation to protect soil from erosion. As soil is washed from around the base of objects on steep slopes, rocks and logs can roll downhill. When walking on slopes, always watch above for rolling objects.

Flash Floods: Because there is no vegetation left to absorb or slow it down, water flowing down hillsides increases after wildfire. When a storm threatens, stay out of canyon bottoms. Remember that a storm that is miles away can send a wall of water downstream where it is not raining.

Plant Identification & Succession

To survive a wildland fire, most plants have adaptive traits or abilities that allow them to reproduce or regenerate after the fire. Such plants are called phyrophytes, literally meaning fire-treated plants.

To survive a fire, a plant must be able to insulate itself from the heat of the flames. Bark thickness is one of the most important factors determining fire resistance of trees. Ponderosa pine, long leaf pine, slash pine, burr oak and giant sequoia are examples of trees with thick bark that act as insulation. Small woody plants and shrubs, which normally have thin bark, tend to use the soil as an insulating layer to protect their roots. Individual plants resist being killed in fires by producing new growth (shoots) from underground organs or roots. Some plants protect their buds as an adaptive strategy to survive a fire. Buds can be protected by layers of succulent foliage. The buds of the longleaf pine are protected by a thick cluster of needles. Some plants even protect their buds by locating them within the main stem and roots.

Retention of seeds by plants until a fire does occur and stimulation of seed dispersal by fire are other examples of fire adaptation. A number of pine species around the world, said to be serotinous, have cones that open only as the result of heat from a fire. Their cones are held closed by a resin that is sensitive to and opens in high temperatures generated by wildland fires. Serotinous cones will not open to release the seeds until the critical temperature is reached. Some cones, such as those on giant sequoia trees, will not open unless burned by fire. Today, people are beginning to recognize that fire is not always destructive. Fire is merely a means of change in ecosystems.

A hot wildfire burns all the seeds available on the ground and kills most or all the seeds that lie buried in the forest soil. Wildfire also takes away the sources of new seeds that could regrow both the canopy and understory vegetation.

Yet, a burned forest doesn't stay totally barren for very long. The first plants to appear in a burned area are the plants that easily sprout from roots. The roots of some plants that grow beneath four to eight inches of soil are insulated from the heat of a wildfire. When a fire removes the leaves of these plants, a chemical signal stimulates the growth of shoots from the roots. These shoots can reach the surface only a few weeks after a fire. In ponderosa pine forests, Gambel and other oaks sprout in this way. Aspens, too, grow from the roots of fire-killed trees.

Within a few weeks of a fire, seeds from nearby, unburned stands of forest can blow into the burned area on the wind, or can hitchhike in the fur of mammals. Grasses and some kinds of wildflowers that were found in the forest before the fire start to grow. Other species that thrive on bare soil can go wild.
A year after a fire in ponderosa pine forests, red-stemmed goosefoot plants can grow by the millions.

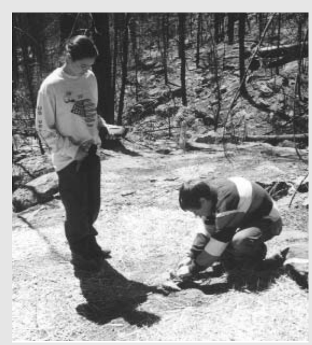
Aspen shoots grow in the Cerro Grande burn area the year after the fire. These fast growing trees need fires to open the canopy so that their seeds receive enough light to grow.

Global Positioning System

Locating a sampling plot on a map was once a difficult process. Since the invention of the Global Positioning System (GPS), finding exact locations is no more difficult than using the remote control for a television. The system consists of the satellite component and the receiver component. Under the right conditions, handheld GPS receivers are accurate within 10 feet.

The GPS is a system of 24 satellites. The satellites:

- orbit at 11,000 miles above the earth's surface
- take about 12 hours to complete one orbit
- are spaced so that at least 4 are always in view of an observer at any point on Earth
- contain a controlling computer and communicate with the Earth via radio
- are powered by solar cells
- use atomic clocks to generate and transmit time signals



A GPS receiver locks onto the timing signals to determine the receiver's latitude, longitude, and elevation. Scientists use the GPS in a wide variety of studies. The data can be used to mark the location of a study area on a map, or to re-locate a plot on the ground.

GPS readings need to be precise. This requires recording latitude and longitude in degrees, minutes, seconds, and tenths of seconds.

- Each degree of latitude is about 70 miles.
- Dividing a degree into 60 minutes makes each minute about 1.1 miles.
- Dividing a minute into 60 seconds makes each second about 90 feet.
- Dividing a second into tenths permits the user to be accurate within 9 feet.

Crown Fires Strike the Nation

On May 10, 2000, the Cerro Grande Fire, pushed by high winds up to 54 mph, swept through Los Alamos, New Mexico. In its path, the wildfire burned 235 structures and left 400 families homeless. Before the fire was out more than two months later, it had charred more than 42,000 acres of forest in the Jemez Mountains.

The Cerro Grande Fire
May-July 2000
Location: Bandelier National Monument & Santa Fe National Forest

On May 7, 2000, what had started as a prescribed fire jumped the fire lines near the summit of Cerro Grande peak and roared into the ponderosa pine forest below. Winds up to 40 miles per hour pushed the fire toward the city of Los Alamos. When the fire front moved one mile in a matter of minutes, the part of Los Alamos closest to the flames was evacuated.

Before the fire, scientists studied tree rings and fire scars from trees in the ponderosa pine forests near Los Alamos. They discovered that before 1880 fires in the forest had burned through the area every five to ten years. By 1910 the fires stopped. Looking for a cause of this sudden end to fires, researchers found that between 1880 and 1910 huge flocks of sheep came to graze in the forests. Starting around 1910 all fires in the area were put out as quickly as possible. Sheep removed the grassy fuels that spread small fires through the ponderosa pine forest and any fire that did start was put out. With no fire to keep the forest fuels -pine needles, dead trees, and crowds of small live trees-in check, fuels in the forest built up to dangerous levels.

After its initial run, the fire grew slowly through ponderosa pine woods choked with small trees over the next two days.

Just after noon on May 10, wind gusts up to 60 miles per hour pushed the fire into the crowns of the trees on the edge of Los Alamos Canyon. As the flames raced from tree to tree, the wind carried burning fire brands across the canyon and into the city. Within minutes, an evacuation order was given to the 12,000 people living in Los Alamos. The residents hurriedly packed a few belongings and drove slowly out of town. By 4 PM, the streets of Los Alamos were empty.

In the forest, wind gusts fed oxygen to the fire and the crown fire raced two miles in one hour. In the town, some of the homes nearest the forest caught fire. Firemen from all over New Mexico fought the flames in the city. The high winds continued into the night, helping spread the flames from house to house.

In the forest, the fire spread to two directions. One branch of the fire reached toward White Rock, a nearby town where many Los Alamos residents had found shelter. At 1 AM on May 11, the order was given to evacuate White Rock. Many Los Alamos residents were evacuated a second time.

The next morning, parts of Los Alamos still burned. The homes of 400 families were lost. The fire in the forest had moved four miles during the night. Another day of strong winds moved the fire through the Santa Fe National Forest to Santa Clara Pueblo lands.

Dry conditions and plenty of fuel kept the fire burning on a smaller scale until July. By then the fire had burned 42,000 acres.

The mark of a true community is when disaster strikes and everyone from school students to senior citizens pull together to make recovery happen. From tree planting to seeding & mulching, rebuilding trails to learning in classrooms about fire effects, the citizens of Los Alamos worked together to begin the restoration of their mountain.
Craig Martin, Los Alamos County Open Space Specialist

An Early Crown Fire in the Jemez Mountains

La Mesa Fire June 1977
Location: Santa Fe National Forest and Bandelier National Monument

A few minutes before 4 PM on June 17, 1977 the St. Peters Dome lookout ranger reported a thin column of smoke on Mesa del Rito. By 4:30 PM, flames and heavy smoke covered the countryside. The human-caused fire started in a slash pile near a dirt road.

In less than two hours, the fire grew to 50 acres. Hot, dry, and windy conditions led to a rapid spread. The fire burned in heavy ponderosa pine forest on the mesas, and cinders fell on the town of White Rock eight miles downwind. For seven days, the fire burned through pine forest. On the night of June 23, a heavy thunderstorm doused most of the fire and it was declared controlled. The fire burned about 15,300 acres.

An Arizona Example

Rodeo-Chediski Fire
Location: Fort Apache Indian Reservation and Apache-Sitgreaves National Forest,
June-July 2002

On June 18, 2002 a human-caused fire spread north from near the rodeo grounds on the White Mountain Apache Reservation. Wind pushed the fire north into the world's largest stand of ponderosa pine along the 50-mile Mogollon Rim in central Arizona. Two days later, a lost hiker tried to signal a helicopter by lighting a fire. Winds quickly pushed the fire up Chediski Peak, which was 15 miles from the growing Rodeo Fire.

Both fires found abundant fuel in the overgrown stands of ponderosa pine, and plenty of oxygen in the strong, dry summer winds. Towns to the north were evacuated. By June 22, the fire reached the top of the rim and raced into the towns of Heber and Overgaard, destroying more than 400 homes.

On June 23, the two fires combined into one huge fire called by many The Monster, the largest recorded fire in the history of the Southwest. About 30,000 people were evacuated from nearby towns. By the time the fire was contained in July, it had burned almost 500,000 acres.

Forest Recovery After a Crown Fire

(left to right) A burned section of Rendija Canyon shows that few trees survived the heat of the Cerro Grande fire in this part of the canyon; Following reseeding efforts by volunteers, the same section in the canyon has many grasses growing the following year; Heavy flooding affected a burned area in Valle Canyon during the summer rains following the Cerro Grande fire; Volunteers reconstruct a trail damaged by the Cerro Grande fire.

THE FLAMES AND HEAT ARE JUST THE BEGINNING OF THE DAMAGE TO AN ECOSYSTEM CAUSED BY A CROWN FIRE.

Often all vegetation is killed and no tree leaves, conifer needles, or ground cover remain to absorb the impact of falling raindrops or to slow the flow of water across the hillsides. Beginning with the first rainstorm, forest soil begins to erode and is often washed away. In mountain ranges in the Southwest, soil can take 10,000 years to develop. Rainstorms can dump millions of gallons in a watershed in less than an hour. Such storms produce flash floods. Compared to the flow of the streams before the fire, the post-fire flows can be 1,000 times greater.

Intense heat can kill most of the seeds lying in the forest soil. But some plants, such as aspen and oaks, have underground roots deep enough to survive the fire. Within weeks, the surviving roots send up shoots. Aspen sprouts can grow three feet high in the weeks following a wildfire. Oak roots can send up dozens of sprouts. Also, the wind and birds carry seeds from areas outside the burn and drop them on the ash-covered soil. Depending on the climate conditions, many grass and wildflower species come back to a burned area in the first two years.

After a wildfire, it is often a race to get living plants growing before the first rains of the summer to help hold the soil in place. Land managers often operate emergency seeding projects. Because grass plants are quick-growing and have an extensive system of fibrous roots, they are ideal for holding soil. Grass seeds can be scattered by hand or from the air with helicopters or airplanes. Because they are adapted to the conditions in the ecosystem, native grass species are used. The seeds grow best when a layer of straw mulch covers them. After the Cerro Grande fire, much of the seeding and mulching was done by volunteers.

Wildfire can destroy ponderosa pine seeds in the soil. In areas of extensive crown fire, live trees that could provide new seeds may be miles away. It is important to plant ponderosa pine seedlings to regenerate the forest and to provide a source of seeds for the future. Seedlings-usually no more than six-inches tall-are planted in many burned areas. More than 200,000 seedlings have been planted on the Cerro Grande fire.

Both the ecological and human recovery from wildfires is very slow. The community of Los Alamos, with the help of thousands of people in New Mexico, survived the Cerro Grande Fire. In their own words:

We will rebuild and rise out of the ashes. Senator Steve Stoddard, retired resident of Los Alamos

A disaster survivor is anyone affected by the Cerro Grande Fire. Losing your home, living in a damaged home, as well as having your sense of safety and well-being compromised by the evacuation makes you a survivor. Project Recovery

Quemazon Trail by Caryn Kohlrust
(Mountain Elementary School
6th Grader)

Quiet is this deserted place,
Unique in its own way as,
Erosion comes far and near when
Mammals have left,
As many people come and go,
Zillions of lizards and insects remain,
On and under rocks, with,
Nothing left of their home.

Though we know the
Reason the fire has come, the
Amphibians and
Insects might not, some of us are
Looking for what s left of our homes.

Reactions to Burned Forests

The sight of a severely burned forest touches everyone, even the most hardened firefighter. The forest, both before a fire and after, evokes difference sensory experiences and emotions in each of us. How does a burned forest make you feel? You may be surprised to find beauty even in the blackness.

On way of expressing feelings about a burned forest is to create a work of art or poem. David Hockney, an artist best known for paintings, also worked with photographs he called joiners. Joiners is a method of taking many photographs, or the individual parts, of a subject and piecing the prints together to recreate the scene in a photo collage. Hockney combined multiple views of a single scene in order to explore the way people shift their gaze in many directions as they observe something.

Creating Defensible Space

Create a FireWise Home

by Cameron Ott, Collin Delano, and Sarah Wyman

Sixth graders at Mountain Elementary School in Los Alamos have suggested the following ways to help prevent a wildfire from destroying your home:

1. Clean your roof and keep gutters free of debris like pine needles.

2. Move woodpiles away from your house.

3. Clear brush around your home to create at least a thirty foot defensible space.

4. Landscape with fire resistant vegetation.

5. Keep flammables, like propane tanks, 50 feet away from your house.

6. Create fuel breaks by strategically placing sidewalks, graveled paths, fish ponds, and walls.

7. Whenever possible, use fire resistant building materials such as metal roofing

Visit www.firewise.org for more information.

Living on the Edge: Defensible Space

People who live in high risk wildfire areas are faced with the growing concern that a wildfire could damage or destroy their home and property. Every year many families lose their homes and possessions to wildfire. These losses can be minimized if homeowners take a pro-active approach to home safety. When homeowners take the time to become aware of appropriate safety measures and put forth the effort to implement those measures, they often greatly improve the ability of fire fighters to protect their homes, and will reduce their vulnerability to the destructive forces of fire.

Defensible space is one of the primary determinants of a building's ability to survive a wildfire. The goal of creating defensible space is to develop a landscape around a building that provides an opportunity for firefighters to defend it against fire. When grasses, brush, trees, and other common forest fuels are removed, reduced, or modified in a yard, a fire's intensity or nearness to a structure decrease. That situation provides a space for firefighters to battle the blaze. Defensible space is not a guarantee that a structure will survive, but it often increases the chances of protection from wildfire.

Creating a defensible space stats with landscaping. You should remove all burnable vegetation from a distance of at least 30 feet from your house. You may have to cut down trees or remove brush. Pine needles should be no more than two inches deep. All other dead vegetation should be removed. If there are many pine trees around the house, you should thin the forest by removing many of the trees. Any smaller trees or low branches that could act as ladder fuels should be taken out.

You can replace some of the vegetation around your house with fire-resistant plants. These plants usually have a high moisture content in the leaves that makes them more difficult to burn. Trees like maples, walnuts, and willows are good choices. Wildflowers and grasses can help create a more defensible space.

Houses near the edge of the forest should be built with safe, resistant materials. A metal roof and walls of stucco or adobe offer good fire protection. Wooden decks are highly flammable and should be protected with special materials.

Other actions can make a big difference. Keep the yard clean of debris. Clean the roof and gutters at least twice a year. Move piles of firewood at least 30 feet from the house. Propane tanks should be used or stored away from the house.

Every family who lives in the ponderosa pine ecosystem should make a defensible space plan.

Extension activities

Visit a nearby ponderosa pine forest. Try to find the following features and answer the questions.

Find a tree with a cat-face scar near the base. From which direction do you think the wind was blowing during the fire?

Find a tree that has been cut with a saw. How old was the tree when it was cut? Are there any fire scars interrupting the rings?

Locate a dog-hair thicket. How deep is the layer of pine needles on the forest floor? How many kinds of wildflowers do you see growing there?

Find a tall, orange-barked ponderosa pine. How far above the ground are the first branches? What does the bark smell like?

Locate a small ponderosa pine with needles you can reach. If you break a needle in two, does it release a pleasant smell?

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Acre: a unit of area equal to 43,560 square feet.

Acquisition time: the time it takes a GPS receiver to acquire satellite signals and determine the initial position.

Adaptation: an alteration in structure or function of a plant or animal that helps it change over the course of successive generations in order to be better suited to live in its environment.

Background: all objects that come from behind the subject away from the camera.

Basal area per hectare: the area of the cross-section of tree stems near their base, generally at breast height and including bark, measured over 1 ha of land.

Biodiversity: the diversity of plants, animals, and other living organisms in all their forms and levels of organization, including genes, species, ecosystems, and the evolutionary and functional processes that link them.

Bole: trunk of a tree

Breast height: the standard height, 1.3m above ground level, at which the diameter of a standing tree is measured.

Camera angles: the area seen by a lens or viewfinder; or the positioning of the subject in relation to the camera shot.

Cambium: the single layer of cells between the woody part of the tree and the bark. Division of these cells results in diameter growth of the tree through formation of wood cells (xylem) and inner bark (phloem).

Canopy: the forest cover of branches and foliage formed by tree crowns.

Centimeter (cm): in the metric system, a unit of length defined as 1/100 of a meter, equal to 10 millimeters or 1/10 of a decimeter.

Circumference: the distance around a circle or sphere.

Clinometer: a simple instrument for measuring vertical angles or slopes. In forestry, used to measure distance and tree heights.

Coordinate: a number used to locate a point on a number line, or either of two numbers used to locate a point on a coordinate grid.

Combustible debris: items that catch fire and burn easily; flammable.

Commercial thinning: a silviculture treatment that thins out a thick stand of trees by removing trees that are large enough to be sold as products such as poles or fence posts. It is carried out to improve the health and growth rate of the remaining trees.

VOCABULARY

Competing vegetation: vegetation that seeks and uses the limited common resources (space, light, water, and nutrients) of a forest site needed by preferred trees for survival and growth.

Competition: the struggle among individual organisms for food, water, space, etc. when the available supply is limited.

Composition: the proportion of each tree species in a stand expressed as a percentage of the total number, basal area or volume of all tree species in the stand.

Crown fire: a fire that burns primarily in the leaves and needles of trees, spreading from tree to tree above the ground.

Damaged timber: timber that has been affected by injurious agents such as wind (as in the case of blowdown), fire, insects, or disease.

Debris flow: mixture of soil, rock, wood debris and water which flows rapidly down steep gullies; commonly initiate on slopes greater than 30.

Deciduous: perennial plants which are normally leafless for some time during the year.

Defensible space: an area around a structure where fuels and vegetation are treated, cleared, or reduced to slow the spread of wildfire towards the structure, giving firefighters a chance to defend the structure.

Data: information usually gathered by observation, questioning, or measurement.

Density: In plant ecology, DENSITY = (Total number of individuals)/total area).

Diameter: a line segment that passes through the center of a circle (or sphere) and has endpoints on the circle (or sphere); also, the length of such a line segment. In forestry, a line passing through the center of a tree.

Diameter tape: a graduated tape based on the relationship of circumference to diameter which provides direct measure of tree diameter when stretched around the outside of the tree, usually at breast height.

Dichotomous key: a tool used by scientists to find the identity of a butterfly, a plant, a rock, or anything else. Dichotomous means divided in two parts. A key is used by answering a series of yes or no questions.

DBH: Diameter breast height; the bole diameter of a tree measured outside the bark at a height of 1.3 meters.

Disturbance: a discrete event, either natural or human-induced, that causes a change in the existing condition of an ecological system.

Dominance (Dominant): the extent to which a given species predominates in a community because of its size, abundance, or coverage.

Drought: a time when there is little or no precipitation such as rain or snow.

Duff: the layer of partially and fully decomposed organic materials lying below the litter and immediately above the mineral soil.

Ecological balance: a state of dynamic equilibrium within a community of organisms in which genetic, species and ecosystem diversity remain relatively stable, subject to gradual changes through natural succession.

Ecology: the science that studies the ways in which plants and animals live together in the natural environment of our planet.

Ecosystem: a functional unit consisting of all the living organisms (plants, animals, and microbes) in a given area, and all the non-living physical and chemical factors of their environment, linked together through nutrient, cycling and energy flow. An ecosystem can be of any size- a log, pond, field, forest, or the earth s biosphere but it always functions as a whole unit. Ecosystems are commonly described according to the major type of vegetation, for example, forest ecosystem, old-growth ecosystem, or range ecosystem.

Ecotone: a transition area between two adjacent ecological communities usually exhibiting competition between organisms.

Elevation: the height above sea level.

Endangered species: a species in danger of extinction.

Estimate: a ballpark answer, a number close to another number, a calculation of a close, rather than exact, answer.

Evergreen: never entirely without green foliage, leaves persisting until a new set has appeared.

Fire: a self-sustaining chemical reaction that can release energy in the form of light and heat.

Fire behavior: the manner in which a fire reacts to fuel, weather and topography; common terms used to describe fire behavior include smoldering, creeping, running, spotting, torching and crowning.

Fire danger: an assessment of both fixed and variable factors of the fire environment, which determine the ease of ignition, rate of spread, difficulty of control, and fire impact.

Fire hazard: the potential fire behavior for a fuel type, regardless of the fuel type s weather-influenced fuel moisture content or its resistance to fireguard construction. Assessment is based on physical fuel characteristics, such as fuel arrangement, fuel load, condition of herbaceous vegetation, and presence of elevated fuels.

Fire impact(s): the immediately evident effect of fire on the ecosystem in terms of biophysical alterations (e.g., crown scorch, mineral soil erosion, depth of burn, fuel consumption).

Fire history: the chronological record of the occurrence of fire in an ecosystem.

Fire intensity: a general term relating to the heat energy released in a fire.

Fire-resistant species: species with morphological characteristics that give it a lower probability of being injured or killed by fire than a fire-sensitive species, which has a relatively high probability of being injured or killed by fire.

Fire scars: scar tissue that develops if a tree or shrub is burned by a fire but is not killed. The fire leaves a record of that particular burn on the plant. Scientists can examine fire scars and determine when and how many fires occurred during the plant s lifetime.

Fire suppression: all activities concerned with controlling and extinguishing a fire following its detection. Synonymous with fire control.

Fire triangle: the three components that are necessary for a fire to take place and for the fire to keep burning; the ingredients are heat, fuel, and oxygen.

Firewise landscaping: management of vegetation that removes flammable fuels from around a structure to reduce exposure to radiant heat. The flammable fuels may be replaced with green lawn, gardens, certain-individually spaced green, ornamental shrubs, individually spaced and pruned trees, decorative stone or other non-flammable or flame-resistant materials.

Food chain: a chain of organisms, linked together because each is food for the next in line. Energy passes from one level to next. All the food chains in an ecosystem are connected together in a complex food web.

Forest fire: an uncontained and freely spreading combustion that consumes the natural fuels of a forest, such as duff, litter, grass, dead branch wood, snags, logs, stumps, weeds, brush, foliage, and, to a limited degree, green trees.

Forest management plan: a general plan for the management of a forest area, usually for a full ration cycle, including the objectives, prescribed management, activities and standards to be employed to achieve specified goals. Commonly supported with more detailed development plans.

Forest health: a forest condition that is naturally resilient to damage; characterized by biodiversity, it contains sustained habitat for timber, fish, wildlife, and humans, and meets present and future resource management objectives.

Formula: a general rule for finding the value of something. A formula is usually written as an equation with variables representing unknown quantities.

Fuel: all the dead and living material that will burn. This includes grasses, dead branches and pine needles on the ground, as well as standing live and dead trees. Also included are minerals near the surface, such as coal that will burn during a fire, and human-built structures.

Fuel load: the amount of combustible material (living and dead plants and trees) that is found in an area.

Global Positioning System (GPS): a global navigation system based on 24 or more satellites orbiting the earth at an altitude of 12,000 miles and providing very precise, worldwide positioning and navigation information 24 hours a day, in any weather.

GPS coordinates: a set of numbers that describes your location on or above the earth. Coordinates are typically based on latitude/longitude lines of reference or a global/regional grid projection.

GPS distance: the length (in feet, meters, miles, etc.) between two waypoints or from your current position to a destination waypoint. This length can be measured in straight-line (rhumb line) or great-circle (over the earth) terms.

GPS receiver: consists of the circuitry necessary to receive the signal from GPS satellites and uses the information to calculation the user s position on the earth.

Ground fire: fire that burns in the organic material in the litter layer, mostly by smoldering combustion. Fires in duff, peat, dead moss and lichens, and downed wood are typically ground fires.

Habitat: the place where an organism lives and/or the conditions of that environment including the soil, vegetation, water, and food.

Hazard tree: a live or dead tree whose trunk, root system or branches have deteriorated or been damaged to such an extent as to be a potential danger to human safety.

Heat: necessary ingredient for fire to start; can be supplied by lightning or human sources.

Hectare: an area of 10,000 square meters, or 100 x 100 meters. There are 100 hectares in a square kilometer.

Human impact or influence: a disturbance or change in ecosystem composition, structure or function caused by humans.

Increment borer: a tool used to extract a core of wood from a living tree for the purpose of studying the annual growth rings of the tree.

Invasive species: species that can move into an area and become dominant numerically or in terms of cover, resource use, or other ecological impacts.

Joiner photographs: multiple frame images shot from different angles and later joined together to recreate the scene or person.

Juvenile spacing: a silvicultural treatment to reduce the number of trees in young stands, often carried out before the stems removed are large enough to be used or sold as a forest product. Prevents stagnation and improves growing conditions for the remaining crop trees so that at final harvest the end-product quality and value is increased. Also called pre-commerical thinning.

Keystone species: a species that plays an important ecological role in determining the overall structure and dynamic relationships within a biotic community. A keystone species presence is essential to the integrity and stability of a particular ecosystem.

Ladder fuels: fuels that provide vertical continuity between the surface fuels and crown fuels in a forest stand, thus contributing to the ease of torching and crowning.

Latitude: the degree measure of an angle whose vertex is the center of the Earth and on side is a radius to the equator. Used to indicate the location of a place with reference (north or south) to the equator.

Litter: the top layer of the forest floor that includes freshly fallen leaves, needles, fine twigs, bark flakes, fruits, matted dead grass and other vegetative parts that are altered little by decomposition. Litter also accumulates beneath rangeland shrubs. Some surface feather moss and lichens are considered to be litter because their moisture response is similar to that of dead fine fuel.

Longitude: the degree measure of how far east or west of the prime meridian a location is on Earth: determined by the angle formed by semicircles of longitude connecting the North Pole and South Pole and the prime meridian.

Maximum density: the maximum allowable stand density above which stands must be spaced to a target density of well-spaced acceptable stems to achieve free-growing status.

Meter (m): the basic unit of length in the metric system, equal to 100 centimeters, and 1000 millimeters.

Monitoring: the periodic measurement or observation of selected physical and biological parameters for establishing base lines and for detecting and quantifying changes over time.

Monitoring plot: a plot installed for measuring or calibrating actual growth of treated stands. The objective is similar to that of research plots but usually limited to one or two treatments; for example, thinned versus unthinned areas. These are usually permanent plots administered by the National Forest system, sometimes in cooperation with Forest Management Research.

Mixed stand: a stand composed of two or more tree species.

Mortality: death or destruction of forest trees as a result of competition, disease, insect damage, drought, wind, fire and other factors (excluding harvesting).

Noxious weeds: any weed so designated by the Weed Control Regulations and identified on a regional district noxious weed control list.

Old growth forest: forest which has not had significant unnatural disturbances altering its content or structure since European settlement.

Organizing data: arranging and presenting data in a way that makes the data easier to understand.

Overgrazing: the practice of grazing too many ruminants on land unable to recover tis vegetation or of grazing ruminants on land not suitable for grazing because of slope. Overgrazing exceeds the carrying capacity of a pasture.

Percent(%): per hundred, or out of a hundred. 1% means 1/100 or 0.01.

Phleom: a layer of tree tissue just inside the bark that conducts food from the leaves to the stem and roots. See Cambium

Photo collage: an artistic composition made of various materials (such as paper, cloth, or wood) glued on a picture surface.

Pioneer plants: a succession term for plants capable of invading bare sites, such as a newly exposed soil surface, and persisting there, i.e., colonizing until supplanted by invader or other succession species.

Plant community: an assemblage of plants occurring together at any point in time, thus designating no particular ecological status.

Plant harvesting: the collection of plant life including, but not limited to, bark, berries, boughs, branches, burls, cones, conks, ferns, flowers, grasses, herbs, fungi, lichens, mosses, mushrooms, roots, sedges, shrubs, sprays and twigs.

Plot: a carefully measured area laid out for experimentation or measurement.

Prescribed fire: any fire ignited by management actions to meet specific objectives. Prior to ignition, a written, approved prescribed fire plan must exist, and National Environmental Protection Act requirements must be met.

Pre-settlement fire regime: the time from about 1500 to the mid to late 1800s, a period when Native American populations had already been heavily impacted by European presence and before extensive settlement by European Americans in most parts of North America, before extensive conversion of wildlands for agricultural and other purposes, and before fires were effectively suppressed in many areas.

Prime meridian: an imaginary semicircle on the Earth, connecting the North Pole and South Pole through Greenwich, England.

Random sample: a sample taken from a population in a way that gives all members of the population the same chance of being selected.

Recreation: any physical or psychological revitalization through the voluntary pursuit of leisure time. Forest recreation includes the use and enjoyment of a forest or wild-land setting, including heritage landmarks, developed facilities, and other biophysical features.

Reduction: the removal of plant parts, such as branches or leaves, constitutes reduction. Examples of reduction are pruning dead wood from a shrub, removing low tree branches, and mowing dead grass.

Reforestation: the natural or artificial restocking (i.e., planting, seeding) of an area with forest trees. Also called forest regeneration.

Removal: this technique involves the elimination of entire plants, particularly trees and shrubs, from the site. Examples of removal would be the cutting down of a dead tree or the cutting out of a flammable shrub.

Replacement: Replacement is the substitution of less flammable plants for more hazardous vegetation. For example, removal of a dense stand of flammable shrubs and planting an irrigated, well maintained flower bed would be a type of replacement.

Restoration: the return of an ecosystem or habitat to its original community structure, with its natural complement of species and natural functions.

Sample: a subset of a population used to represent the whole population.

Separation distance: Separation distances are measured between tree canopies (outermost branches) and not between trunks.

Spreadsheet: a table displayed by a computer program, which is used to perform mathematical operations, evaluate formulas, and relate data quickly. The name comes from ledger worksheets for financial records. Such sheets were often taped together and then spread out for examination.

Serotinous: a pine cone or other seed case that requires heat from a fire to open and release the seed.

Snag: a standing dead tree or part of a dead tree from which at least the smaller branches have fallen.

Soil erosion: the wearing away of the earth s surface by water, gravity, wind, and ice.

Solar cell: a device made of semiconductor materials which produce a voltage when exposed to light.

Species: a singular or plural term for a population or series of populations of organisms that are capable of interbreeding freely with each other but not with members of other species.

Stand: a group of plants of the same species, same size, and same age.

Stand density: a relative measure of the amount of stocking on a forest area. Often described in terms of stems per hectare.

Stewardship: caring for land and associated resources and passing healthy ecosystems to future generations.

Succession: the gradual replacement of one plant and animal community by another, as in the change from an open field to a mature forest.

Surface fire: a fire that burns leaf litter, fallen branches and other fuels located on the forest floor.

Thinning: a cutting of specific trees made in a forest stand primarily to promote tree growth and to improve the average form of the trees that remain.

Thumbnail sketch: very quick, loose drawing.

Understory: any plants growing under the canopy formed by other plants, particularly herbaceous and shrub vegetation.

Vegetation: plant life in general

Watershed: an area of land that collects and discharges water into a single main stream through a series of smaller tributaries.

Wildfire: an unplanned or unwanted natural or human-caused fire or a prescribed fire that has escaped its bounds.

Wildland/Urban Interface: a popular term used to describe an area where various structures (most notably private homes) and other human developments meet or are intermingled with forest and other vegetative fuel types.

Zeric: having very little moisture; tolerating or adapted to dry conditions.

WHY DO FORESTS BURN? EXPLORING FIRE BEHAVIOR

Pre-Visit LESSON PLAN

FOCUS QUESTIONS

Why do some wildfires burn entire forests and others do not?

How do firefighters break the fire triangle to control a wildfire?

OVERVIEW OF LESSON PLAN

Students will arrive at a basic knowledge of the fire triangle through four activities. They will extend this knowledge into the realm of wildland fire, identifying the key components of the fire triangle in the natural world. Simple demonstrations will show students how forest density, slope, and weather conditions affect the nature of wildland fire. For a fun way to study fire behavior, students can play a game of fire tag.

SUGGESTED TIME ALLOWANCE: Class Time: 3 hours

LOCATION: Classroom, school yard

SUBJECT AREAS: Science, Math, Technology

STUDENT OBJECTIVES

Students will:

- Correctly identify the three parts of the fire triangle
- Relate parts of the fire triangle to the forest environment
- Evaluate the effects of slope, forest density, and wind on fire behavior
- Explain how firefighters attack the fire triangle to put out a wildfire

VOCABULARY

- Fire triangle
- Crown fire
- Fire behavior
- Slope
- Forest density

MATERIALS

Three Parts of the Fire Triangle

- Candle
- Pie pan
- Modeling clay
- Matches
- Tall, wide-mouth jar
- Scissors
- Field journals
- Pencils

The Fire Triangle in the Real World

- Investigating Fire Ecology newspaper
- Field journals
- Pencils

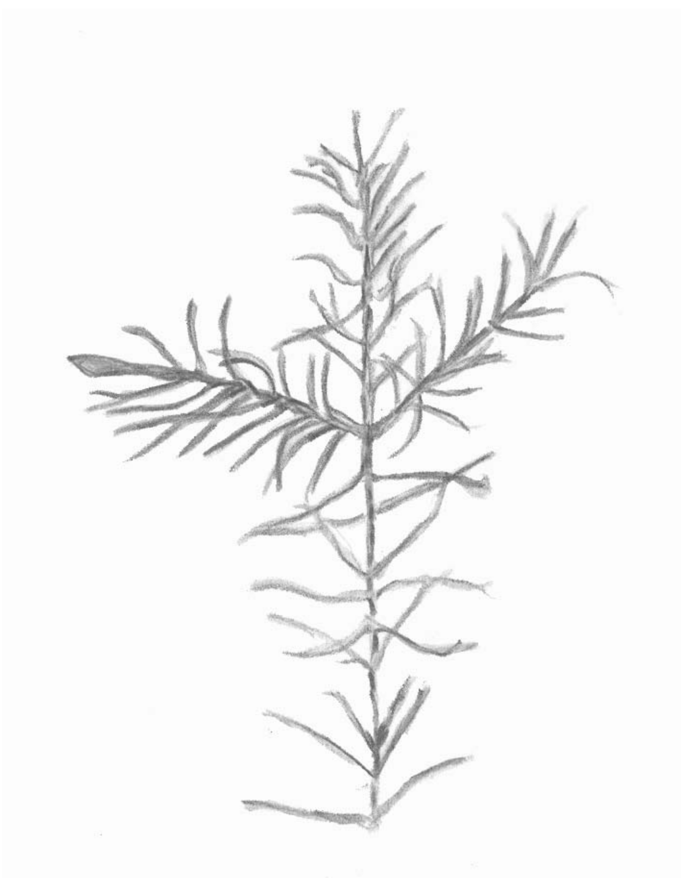
Pre-Visit LESSON PLAN

Materials (cont.)

Fire Behavior:
How, Where, And When A Fire Burns Can Affect The Fire Triangle

- Kitchen matches
- Non-toxic modeling clay (potters clay to prevent melting)
- Metal trays
- Recycled spray bottles for water
- Stopwatch
- Thermometer
- Heat resistant mittens or oven hot pads
- Fire extinguishers
- Safety glasses
- Data sheets

Fire Tag
- Yellow arm bands for one quarter of the students
- Blue Nerf balls for one quarter of the students



PROCEDURES

Three Parts of the Fire Triangle

1. Before class, use the modeling clay to hold the candle securely in the pie pan.

2. Draw a triangle on the board or overhead. Ask students what is needed for a fire. Write answers on the board. Then use the answers to organize the three parts of the Fire Triangle: heat, fuel, and oxygen. Include in the discussion the following questions: Burnable things surround us every day. Why aren t they on fire? What is the fuel in fires we are familiar with?

3. With a candle, demonstrate that if any of the three sides of the fire triangle is broken, there is no fire.

4. Stare at the candle for a moment. Ask why it is not burning? What is missing from the fire triangle? (Heat)

5. Light the candle. Place the jar over the candle. Wait until the candle goes out. Ask why the candle is no longer burning. What is missing from the fire triangle? (Oxygen)

6. Light the candle again. Use scissors to cut the wick. What is missing from the fire triangle? (Fuel)

The Fire Triangle in the Real World

Have students read about the fire triangle in the real world in their newspaper.

Students should record in their field journal:

Three sources of heat for wildfires
Four types of fuel for wildfires and classify each as light fuel or heavy fuel
Two ways that wind increases the oxygen for a wildfire

FIRE BEHAVIOR:
HOW, WHERE & WHEN A FIRE BURNS CAN AFFECT THE FIRE TRIANGLE

1. Prepare at least four matchstick forests. Build a forest in each tray. Create a 5 x 8 base for trees (matches) from a thin layer of modeling clay by packing firmly to the pan and flattening. In the first three trays, space matches vertically approximately one-half inch apart. In the last tray, place about 20 matches total in well-spaced clumps to mimic historic ponderosa pine forests.

2. Do the demonstrations on a non-flammable surface in the school yard. Place one tray on a flat surface. Elevate one end of a second tray about 20 degrees to represent a moderate slope in the land s topography. Elevate one end of the third tray about 40 degrees to represent a steep slope in the land s topography. For the historic ponderosa forest tray, keep the tray flat or put it on a 20 degree slope.

3. Set the matchstick forests on a heat-resistant surface. If you don t have laboratory facilities, one really good surface to use is a trash-can lid filled with sand. Have a spray bottle and fire extinguisher nearby.

4. Explain to students that the individual matches represent trees that have flammable crowns, like the conifers in local forests. In this demonstration, students will observe how slope and tree density affect fire spread through tree crowns.

5. Discuss the type of observations students should make and record on the data sheet. Make sure students understand the topography of the forest, number of matches (forest density), the time to burn all the matches in seconds, the ambient temperature, and number of unburned trees.

6. Before lighting the matches, ask students for their hypothesis about how the fires will differ.

7. Light the match tips along one edge of the flat forest and observe fire behavior. Then light the match tips along the top edge of a medium-slope forest and observe. Then light the bottom row of matches on the other medium-slope forest and observe. Finally, light the bottom row of matches on the steep forest and observe Ask for descriptions of what the students observe and interpretations in terms of the fire triangle. (Heat travels upward, so the matches and trees uphill from a fire receive more heat than those below and are easier to ignite.)

8. Ask students to remove whatever remains of the matches from each board. They can use the nail in the kit to poke the burned matches out, if necessary.

FIREFIGHTERS AND THE FIRE TRIANGLE

1. Review the fire triangle.
2. Have students discuss ways that firefighters could use knowledge of the fire triangle to stop a wildfire.
   a. Eliminate fuel
   Cut down and remove trees in the path of the fire (create a firebreak)
   Scrape away a wide band of material lying on the ground (create a fire line)
   b. Eliminate oxygen
   Throw water on the fire
   Throw dirt on the fire
   c. Eliminate heat
   Throw water or fire retardant on the fire
3. Play Fire Tag

FIRE TAG

To start, designate one child as the spark (that starts the fire). One quarter of the group will be fire fighters, identified by their yellow arm bands and each equipped with a blue Nerf ball. The remaining students will be trees (or fuel, which allow the fire to grow). At the beginning, explain to the players what each of their roles will be (see below). Have the spark go to one end of the playing area, and align the fire fighters at the other end. Now tell the trees to take root and grow anywhere they wish on the playing field. They should stand with their arms held up to mimic tree branches.

The spark, or lightning, starts the game by tagging a tree. Trees may not run from the fire! Tagged trees become part of the fire and must join hands with the spark. The fire must now continue its pursuit of trees as a unit, attempting to capture trees with their free hands. Captured trees must join the chain of fire.

Fire can either move as a long chain, or may break into several smaller groups and travel as spot fires. They may not travel as individuals (pairs or more only!). This distinguishes them from unburned trees.

Fire fighters should be held on the sidelines until the fire has had a chance to grow to 3-4 players. At this point, ask the fire fighters, Do you smell smoke? They ll be raring to go, so when they yell Yes!, allow them to go put out the fire.

Firefighters must avoid fire (they, too, can become fuel for the fire and must join the fire if caught) while attempting to slow the fire s growth. They can do this in three ways:

1. Removal of fuels Firefighters may tag trees and escort them out of the game to the sidelines. Fire fighters and trees may not be captured by fire en route!

(Adapted from A Teachers Guide to Fire Ecology in New Mexico and the Southwest, New Mexico South Central Mountains RD and D)

2. Direct attack - Firefighters may tag fire with their blue bandanas (water). Fire units that get hit with water must walk from that point on.

3. Containment Fire fighters may join hands to encircle or contain a spot fire (wet fires are the easiest to contain because they walk slowly). Contained spot fires must go to the sidelines.

Summary of goals of players:

TREES: Stand still: you may be captured by either fire or removed to the sidelines by firefighters.

FIRE: Tag trees and fire fighters and grow! Avoid water-wielding firefighters.

FIRE FIGHTERS: Remove trees to sidelines before they are captured by fire. Tag fire with water to slow its advance. Join hands with other fire fighters to encircle spot fires and remove them to the sidelines.

The game is over when no trees remain. Compare the number of fire players left at the end of the game with the number of tree players on the sidelines. Who won, the fire fighters or the fire? Point out the similarities and differences to real life.

EVALUATION

Direct students to design a matchstick forest to observe a different slope, weather, or fuel condition, or to solve a specific problem. For example, make a matchstick forest on a steep slope and then remove 12 trees from it. Find the best arrangement of 12 fewer trees to reduce the risk of fire spread.

Students should be able to explain why their experiment is important, make a prediction of the results, and support their ideas with their knowledge of fire behavior.

Name ____

STUDENT SHEET

Why Do Forests Burn? Exploring the Fire Triangle
Assessment Questions

Comprehensive Paragraph: What are the elements of a fire triangle and what occurs when one of these components is removed from the triangle?

Matching:

Fire Triangle	a. a fire that burns primarily in the leaves and needles of trees, spreading from tree to tree above the ground.
Crown Fire	b. manner in which a fire reacts to fuel, weather, and topography; common terms used to described this activity include: smoldering, creeping, running, spotting and crowning.
Fire Behavior.	c. the three components that are necessary for a fire to take place and for the fire to keep burning

True or False:

1. Trees, flame and weather are the three components of the fire triangle when referring to wildland fires..

   True or False

2. Throwing water or dirt on a fire eliminates the fuels, thus stopping the growth of a fire.

   True or False

Multiple Choice:
The three sources of heat for a wildland fire are ______________, ______________ and ____________________.

Name two ways that wind can add to the intensity of a wild fire.
______________________ and ____________________.

Name at least two types of light fuels ____________, and _______________.

Comprehensive Paragraph:
What are the elements of the fire triangle and what occurs when one of these components is removed from the triangle? How do firefighters take advantage of the fire triangle to stop a fire?

The three elements of the fire triangle are heat, oxygen, and fuel. If any one of the elements is removed, fires will no longer burn. Student should provide an example, such as, cutting a fire break to halt the approach of a fire.

Matching:
Fire Triangle c
Crown Fire a
Fire Behavior b

True or False:
1. Trees, flame and weather are the three components of the fire triangle when referring to wildland fires.. False

2. Throwing water or dirt on a fire eliminates the fuels, thus stopping the growth of a fire. False

Multiple Choice:

1. The three sources of heat for a wildland fire are lightning, fires(campfires), and sparks or power lines.

2. Name two ways that wind can add to the intensity of a wild fire. Provides more oxygen and blows heat/fire to unburned fuel.

3. Name at least two types of light fuels. grasses and brush or small trees.

STUDENT SHEET

Name______________________________ Date____________

DATA SHEET FOR MATCHSTICK FOREST EXPERIMENTS

Experiment 1: ______________________________

Forest density (number of matches) ______________________________

Topography (slope angle) ______________________________

Temperature ______________________________

Other factors ______________________________

Hypothesis ______________________________

Observations:

Time to burn ______________________________

Number of unburned trees ______________________________

Other observations ______________________________

Experiment 2: ______________________________

Forest density (number of matches) ______________________________

Topography (slope angle) ______________________________

Temperature ______________________________

Other factors ______________________________

Hypothesis ______________________________

Observations:

Time to burn ______________________________

Number of unburned trees ______________________________

Other observations ______________________________

STUDENT SHEET

Experiment 3:____

Forest density (number of matches) ____________________________

Topography (slope angle) __________________________________

Temperature ____

Other factors ____

Hypothesis____

Observations:

Time to burn ____

Number of unburned trees __________________________________

Other observations ______________________________________

Experiment 4:____

Forest density (number of matches) ____________________________

Topography (slope angle) __________________________________

Temperature ____

Other factors ____

Hypothesis____

Observations:

Time to burn ____

Number of unburned trees __________________________________

Other observations ______________________________________

WILDFIRE AND NATIVE PLANTS

FOCUS QUESTIONS

What effect does wildfire have on plants?

What are the common types of plant species that inhabit your area after a forest fire?

How can we use a dichotomous key to classify living things?

OVERVIEW OF THE LESSON PLAN

This lesson will introduce students to common plant species found in the region following a forest fire. It will prepare them for a visit to a recently burned forest, where they will interpret, document, and inventory common plants. Back in the classroom, they will compile their information into a field guide. In order to ensure that this lesson is successful, the students will need to identify common plants via available resources in the classroom before going out in the field. Students will identify common species using a set of plant identification cards and a dichotomous key.

SUGGESTED TIME ALLOWANCE: 2 hours

LOCATION: Classroom

SUBJECTS: Science, Language Arts, Math, Art, Technology

STUDENT OBJECTIVES

Students will:

- Respond to the quote Nobody Sees a Flower, by Georgia O Keeffe.
- Develop a working definition with the word adaptation.
- Understand the concept of forest succession.
- Classify objects with a dichotomous key.
- Identify common trees with a dichotomous key.
- Use plant identification cards to develop their own dichotomous key.
- Develop a working knowledge of common plants and an awareness of plant diversity in a fire disturbed area.

VOCABULARY

- Forest succession
- Adaptation
- Serotinous
- Phyrophytes
- Endangered species
- Dichotomous key

MATERIALS

- Websites, books, newspaper articles, encyclopedias
- Overhead pictures of common plants in region (optional)
- Field journals
- Field guides of regional plant life
- Computer with internet and data base access
- Handout: Key to Some Common Trees
- Samples of ponderosa pine, limber pine, juniper, piaon pine, Douglas fir
- Plant identification cards

PROCEDURES

1. Warm up
Write this quotation on the board: Nobody sees a flower, really it is so small we haven t time, and to see takes time, like to have a friend takes time. Georgia O Keeffe. Students respond to this quote in their science journals.

DISCUSSION QUESTIONS:
Do you agree or disagree?
What is the author saying?

WRITING: Create your own saying about flowers and friendships.
Write questions you would like to ask Georgia O Keeffe.

ILLUSTRATING: Express the meaning in visual form with a sketch.
Use color, pattern shapes or shading to interpret the meaning

Think of five ways people are like flowers. Share your answers with the class.

2. Develop a working definition of the word adaptation with students.
Discuss the fact that plant and animal adaptations don t occur over a generation or two but may take thousands of years to evolve. Plants have a distinct disadvantage, compared to animals, in the face of fires. They are unable to run, fly, creep or crawl out of a fire s path and have adapted other methods to survive fires.

Individual plants have adaptations to ensure their survival through a fire. To survive a fire, a plant must be able to insulate itself from the heat of the flames. Bark thickness is the most important factor determining fire resistance of trees. Ponderosa pine, longleaf pine, slash pine, loblolly pine and giant sequoia are examples of trees with thick bark that acts as insulation from forest fires.

Small woody plants and shrubs normally have thin bark. These plants use the soil as an insulating layer to protect themselves. Individual plants resist being killed in fires by producing new growth (shoots) from underground organs or roots. Some plants protect their buds as an adaptive strategy to survive a fire. Buds can be protected by layers of succulent, nonflammable foliage. Longleaf pine exemplifies this adaptive strategy. The buds of the longleaf pine are protected by a thick cluster of needles. Some plants even protect their buds by locating them within the main stem and roots. A few poplar tree species possess this trait.

Retention of seeds by plants and stimulation of seed dispersal by fire are other examples of fire-adaptive strategies. A number of pine species have cones that open only after a fire. These cones are said to be serotinous (pronounced sir-OT-in-ous). Jack pines have cones that are held closed by a resin that is sensitive to high temperatures. These cones will not open to release their seeds until the critical temperature is reached. Cones of Lodgepole pines (a western U.S. variety of tree) vary from serotinous to free-opening.

When these trees grow in areas subject to frequent fires, many of the cones are serotinous. However, if lodgepole pines grow in areas where fire is less frequent, the pine cones open and release their seeds more often without fire.

(Adapted from the Department of Interior, Fire Ecology: Resource Management Education Unit).

Encourage students to give examples of plant and animal adaptations that make it possible for each to live in a particular area. List these in their journals and on the board. Examples for animals might include a box turtle shell that protects it from predators, a great horned owl s talons that enable it to catch and hold its prey, the white tailed deer s coloring that blends with forest vegetation and helps it evade predators.

3. Introduce the concept of forest succession.

Forest ecosystems are always changing. Plants grow using soil nutrients and eventually die, returning nutrients to the soil. Animals feed on plants and leave waste. Bacteria, fungi and insects thrive on decaying plants, animals and animal waste, breaking down these materials and replacing soil nutrients. These interactions of plants, animals, bacteria, fungi, and insects constantly occur in ecosystems.

Succession is a change in plants and animals which occurs periodically in all communities. An open space or meadow will eventually be overgrown by a forest which in turn will grow to a climax forest. The length of time and kinds of plants involved in each successional change depend on many factors. The successional progression can be changed at any state by many different factors and disturbances. These factors and disturbances have negative and positive effects on succession. Disturbances in the forest can be human made or natural.

Much of what we know of the effects of wildfire on plant community succession comes from plots established prior to low intensity prescribed fires or from plots sampled immediately after high intensity crown fires. There is obvious change in the plant community following fire. Some of the species may be practically eliminated, perhaps as many as 50%. Some species increase for a short time probably from the stimulation of burning, increased sunlight, lack of competition, water availability and a slight nutrient increase. They then decline, perhaps as a result of increased competition from plants that tolerate the increased sunlight. Some species decline for a few years then begin to increase to their pre-burn status. Some species that were absent or rare before the fire increase in cover; unfortunately some are non-natives.

(Don G. Despain USGS, Northern Rocky Mountain Science Center)

Ask students what they can expect to find in a forest that has been severely burned.

4. Classifying Objects with a Dichotomous Key

(Adapted from the University of North Dakota Volcano World Curriculum)

Explain to students that a dichotomous key is a tool used by scientists to find the identity of a butterfly, a plant, a rock, or anything else.

Dichotomous means divided in two parts. At each step of the process of using the key, the user is given two choices; each alternative leads to another question until the item is identified. It s just like playing the game Twenty Questions.

Pre-Visit LESSON PLAN

Classification is the process of organizing things into groups. The ability to classify can be a valuable life skill for students. The concept of classification can be used in everyday life. One can use a classification system to organize term papers, books on a shelf, and clothes in a drawer. Classification systems are used in many different ways in the business world.

Biologists organize and store data about organisms in a KEY. A key is a chart that groups organisms by their characteristics.

Shoe Classification

This activity will give students an idea of how a key works.

Imagine walking into a classroom and finding a pile of shoes and a group of shoeless students. Your task is to match the shoes to the correct student.

To use the key, you start at number one and work to the right. As you come to each fork in the road, you make a choice based on the feature of the shoe. Eventually, by a process of deduction, you come to the owner.

For example, you pick up a shoe. It has laces. That places you at 1A. The shoe is not brown. This is 2B. The shoe is white. That is 10B. The shoe has a high top. That is 14A and the owner is Marty. By doing this to every shoe, you can return each shoe to tis owner. You can make a key of shoes for your class, as well.

1. Divide the class into groups of 10 or 12 students.
   Have each student take off one shoe and put it into a center pile.

2. Divide the shoes into two piles. Every shoe in one group must have a feature that no shoe in the other group has. Write this distinguishing feature down as 1A on a chart similar to the handout. Its opposite, then, will be 1B.

3. Ignore one pile of shoes for the time being. Pick another feature that allows you to divide the remaining pile of shoes into two smaller groups. Write this feature and its opposite after 1A as 2A and 2B.

4. Repeat steps until each pile is reduced to one shoe, and the owner s name is filled-in on the chart.

5. Go back to the pile that was left behind and repeat the steps. If you are confused, study the key.

6. To test the accuracy and clarity of your key, ask someone from another group to match one shoe to its owner. (Everyone should cover or remove and hide his/her remaining shoe.)

5. Identifying Common Trees with a Key
Before class, collect sample of the common trees listed in the key or use the samples in the Fire Box.

Divide students into groups of three. Give each group a copy of the Key to Some Common Trees and a sample of each tree.

Explain that all the trees in the key are conifers. These are trees that are evergreen. Their leaves are needles, which are hard, narrow leaves.

Let the students work through the key to identify their samples.

6. Student Generated Dichotomous Key using Plant Identification Cards
Using the knowledge gained in the last two exercises, students can make their own dichotomous key. Sorting can by done by color, family, or other student-generated methods.

Students should familiarize themselves with at least 10 plants they will most likely observe in the field. (Copies of these pages should be available in their science journals for easy reference. Students can identify and color each specific plant before the field trip.)

EVALUATION
Students will be evaluated on their knowledge of using a dichotomous key, and recognizing common plants.
After the field trip, students will produce a field guide to the common plants in the burned area.

Keying Out Trees

Using a dichotomous key is similar to going down the road and coming to a fork or Y in the road. You must decide which direction to go by observing the plant. There are two choices. Each choice will lead to a different plant. The observations are hints to tell you which way to go. So you must first ask some questions!

ASK THE QUESTION: What kind of leaves does the plant have?
Evergreen or Deciduous?

A. Are the trees deciduous (loose their leaves in the fall)?

(GO TO PAGE 2 and continue)

A. Are the trees evergreen (keep their leaves in the fall?)

At this fork ask the question:
What is the shape of the leaf?

b. Is the leaf small and triangular?

You will have to use a magnifying glass to see each leaf.

GO TO PAGE 3 and continue

b. Is the leaf needle-like?

GO TO PAGE 4 and continue

*Reference: Foxx, Teralene and Dorothy Hoard "Flowering Plants of the Southwestern Woodlands." Otowi Press, Los Alamos, 1995; drawings by Dorothy Hoard and Teralene Foxx.

DECIDUOUS TREES

A. Trees generally growing along streams, near springs or other water.

b. Trees with leaves that have more than one leafelet (a compound leaf). Generally growing along streams. Bark pale gray to brown, divided intc narrow ridges. Leaves opposite.

BOXELDER MAPLE
Acer negundo

b. Trees with leaves with a singleleaf blade.

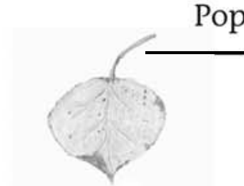
c. Leaves roughly triangular, wider than long. Leaves yellow green. Bark gray. A dominant tree is a forest along a river called a bosque.

RIO GRANDE COTTONWOOD
Populus fremontii

c. Leaves narrow, four times longer than wide. Upper leaf surfaces light-green lower leaf surfacelighter and hairy. Bark gray with narrow fissures. Most often found near streams such as Frijoles.

NARROWLEAF COTTONWOOD
Populus angustifolia

A. Trees generally not growing near water. Trees found in dense groves at higl elevations. Bark whitish. Leaves oval with flattend leaf stem. Often found where there has been a fire and is sometimes called a "fire species."



ASPEN
Populus tremuloides
flattened leaf stem
(petiole)

STUDENT SHEET

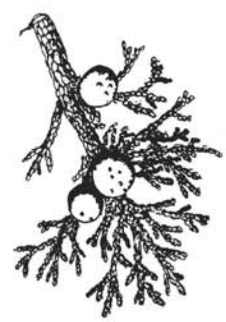
PLANTS WITH SMALL TRIANGULAR LEAVES

Trees are often without one main trunk but multiple branches.
Bark is shreddy.

A. Color of the leaves and branches olive green. Male and female trees. Only the female trees have berries. Bark shreddy, gray, fibrous.

ONE-SEED JUNIPER
Juniperus monosperma

This tree is a common at elevations of 5000-6500 ft. It is one of the main trees in the pinon-juniper woodland and the main tree in a juniper savannah. This is a very hardy tree.



A. **Color of the leaves silver green, drooping, flattened.** Male and female flowers on one tree. Bark reddish brown to gray. Shreddy.

ROCKY MOUNTAIN JUNIPER

Juniperus scropulorum

This tree is found primarily in canyons where there is water or more moisture. There are generally one or two trees in an area, not large groves.

Rocky Mountain juniper

PLANTS WITH NEEDLE-LIKE LEAVES

Needles attached to the twig in bundles of 2 to 5.

b. Needles in bundles of 5. **LIMBER PINE**
Pinus flexilis

These trees are found scattered throughout the forest at 7500-8000 feet. They often grow in rocky places.

b. Needles in bundles of 2-3.

c. Needles in bundles of 3. **PONDEROSA PINE**
Pinus ponderosa

These trees are found in large expanses of forest from 7000-7500 feet and scattered at higher elevations. Bark black to yellow broken into puzzle-like pieces. Smells like vanilla.

c. Needles in bundles of 2. **PINON PINE**
Pinus edulis

These trees are found in large expanses of forest from 6500-7000 ft.

See "A" on page 5: Needles attached to twig singly.

A. Needles attached to the twig singly.

b. **Needles flat** (HINT: Leaves will not twirl between your fingers. Needles are soft, not sharp.)

c. Branches drooping. Leaves blue-green. Cones with three-pointed bracts. Bark reddish to gray brown.

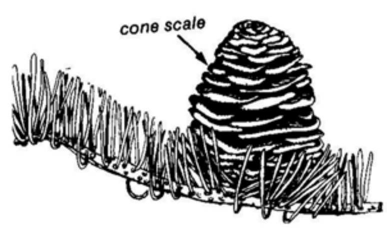
DOUGLAS FIR
Pseudotsuga menziesii

These trees are found most often in canyons or at elevations above 8000 ft. They are in mixed-conifer forests.

c. Branches with needles pointing upward. Leaves pale blue. Cones disintegrate on tree so none will be found under the tree. Bark gray and deeply furrowed.

WHITE FIR
Abies concolor

These trees are found most often in canyons or at elevations above 8000 ft. They are in mixed-conifer forest



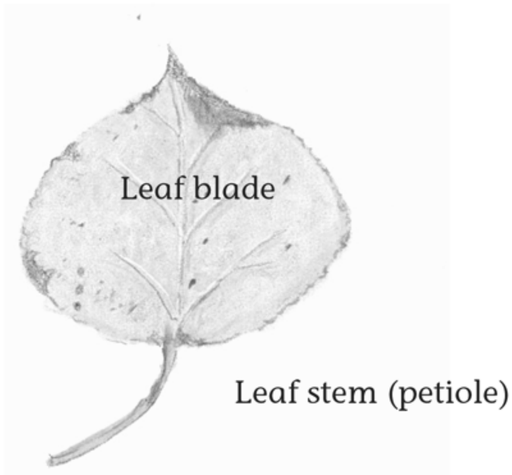
b. **Needles four-angled, sharp pointed.** (HINT: The needles will twirl in your fingers and when you grasp the tree the needles are sharp). Bark cinnamon-red.

SPRUCE
Picea engelmannii

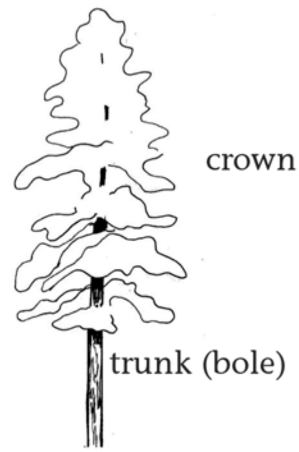
Spruce are generally found at elevations from 8000-10,000 ft.

ABOUT LEAVES

PARTS OF A LEAF

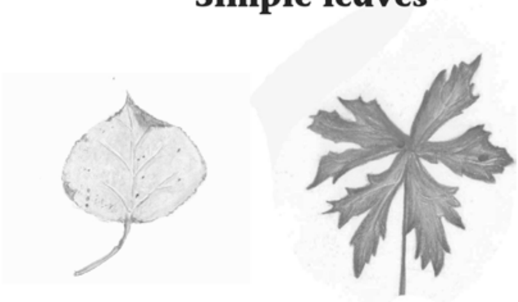


PARTS OF A TREE



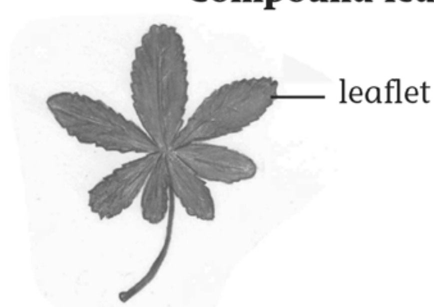
TYPES OF LEAVES

Simple leaves



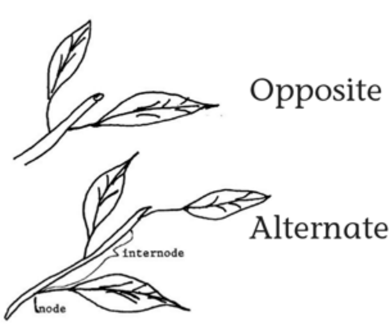
One single blade and leaf stem. Sometimes the small leaflets leaf is deeply incised.

Compound leaves



The leaf is made up of many arranged on the leaf stalk.

HOW LEAVES ARE ON THE STEM



Name ____

Wildfire and Native Plants
Assessment Questions

Comprehensive Paragraph: How do some trees, shrubs and plants protect themselves from the heat and flames of wildland fire and make it possible to grow again on their own?

Vocabulary:

Forest succession	a. necessary ingredient for fire to start.
Adaptation	b. function of plant or animal that helps it change over successive generations.
Serotinous	c. the gradual replacement of a plant or animal community by another.
Phyrophytes	d. a pine cone or seed case that requires heat from a fire to open and release the seed.
Endangered Species	e. means fire-treated plant.
Heat	f. plants or animals that need protection in order to survive.

True or False:

1. Ponderosa pine and longleaf pine have thick bark to insulate them from fire, therefore, they are the only trees capable of surviving a wildland fire.
   a. True b. False
2. When plant collecting, it doesn t matter how much of the plant is collected, because, as long as it is cut properly with sharp shears the plant will always grow back.
   a. True b. False

Multiple Choice:

3. Which of the following have the slowest reproductive rate and grow more slowly than other types of plants and therefore should only be collected sparingly?
   a. grasses b. wildflowers c. vegetables d. mushrooms

4. Which type of pine cone is actually opened by the heat of a wildfire allowing the cone to drop its seed for new growth?
   a. phyrophyte cones b. serotinous cones
   c. endangered cones d. adaptive cones
5. Forest ecosystems are always changing. Which of the following has direct interaction within the management of a forest ecosystem?
   a. bacteria, fungi, animal waste b. insects, dying plants, animals
   c. insects, animals, plants d. all of the above

TEACHER MASTER

Comprehensive Paragraph: How do some trees, shrubs and plants protect themselves from the heat and flames of wildland fire and make it possible to grow again on their own?

Insulation, adaptive traits, reproduction, regeneration, bark thickness, heat opening pine cones, self-protecting

Matching:
Forest succession c
Adaptation b
Serotinous d
Phyrophytes e
Endangered Species f
Heat a

True or False:

3. Ponderosa pine and longleaf pine have thick bark to insulate them from fire, therefore, they are the only trees capable of surviving a wildland fire. False

4. When plant collecting, it doesn t matter how much of the plant is collected, because, as long as it is cut properly with sharp shears the plant will always grow back. False

Multiple Choice:

5. Which of the following have the slowest reproductive rate and grow more slowly than other types of plants and therefore should only be collected sparingly?
b. wildflowers

6. Which type of pine cone is actually opened by the heat of a wildfire allowing the cone to drop its seed for new growth? b. serotinous cones

7. Forest ecosystems are always changing. Which of the following has direct interaction within the management of an forest ecosystem? d. all of the above

MEASURING THE EARTH FROM THE GROUND UP

Pre-Visit LESSON PLAN

FOCUS QUESTIONS
When doing a science study, how can we make estimates of distance & how can we make precise measurements of distance?

OVERVIEW OF LESSON PLAN
Students will practice measuring techniques from estimating distance with the length of their pace to using the Global Positioning System and its satellites to precisely map locations around their school. They can determine the length of their pace, use measuring tapes and simple trigonometry to lay out a rectangle on the ground, and use a GPS to collect data about their school. Each of the activities will prepare students for tasks to which they will be assigned during the field study.

SUGGESTED TIME ALLOWANCE: 2 hours

LOCATION: Classroom, school, school yard

SUBJECT AREAS: Social Studies, Science, Math, Technology

STUDENT OBJECTIVES
Students will:

- Determine their pace and apply the knowledge to measuring a part of their school
- Use simple mathematics to lay out a rectangle on the ground
- Know how to turn a GPS receiver on and off, and to page between the screens
- Know how to find their position with a GPS receiver

VOCABULARY
- Latitude
- Longitude
- Coordinate
- Satellite
- Global Positioning System (GPS)
- GPS Receiver

MATERIALS
- Field journals
- Pencils

Estimating distance and area by pacing
- Measuring tapes
- String
- Pin flags
- GPS receivers

Using Measuring Tapes To Lay Out A Rectangle
Measuring tapes, either 10, 30, or 50 meters
String
Sets of four pin flags marked A through D
Marking pens

THREE SCHOOLYARD ACTIVITIES FOR GPS RECEIVERS

Flag Finder
Pin flags marked A through M
GPS receivers
Datasheets

Testing GPS Accuracy
30-meter measuring tapes
GPS receivers
Datasheets

Where in the World is My School? Using Mapping Software
GPS receivers
Datasheets
Mapping software, such as Terrain Navigator
LCD projector

PROCEDURES

The exercises below can be run one at a time or as stations in a Measuring Marathon activity.

Estimating distance and area by pacing

1. In the school yard or in a hallway, use a measuring tape to lay out one or several lines or strings that are 10 meters long.
2. Practice walking in a normal manner, using a comfortable length of step.
3. Start at the beginning of the line. Walk along the string, count the number of steps it takes to reach the end.
4. Divide the number of steps by 10 to find the length of your pace in meters.
5. Repeat three times and estimate your average pace from the three trials.
6. Put out a 25 meter string. Have students estimate the length of the string.
7. In a wide-open part of the school yard, mark off an area of one acre with pin flags. An acre is a square with 640-foot sides.

Using Measuring Tapes To Lay Out A Rectangle

1. Locate a place in the school yard where groups of students can lay out 8 by 10 meter rectangles. Make up student kits that include a measuring tape, string, four coded pin flags, and a marking pen. Divide students into groups of 3 or 4. Push the A pin flag into the ground as a corner of your rectangle.

2. Using the measuring tape, start at the A corner and measure a line that is 10 meters long. Push in the B pin flag to mark a second corner. Run a string between the two corners. Use the measuring tape to mark a spot on the string that is 3 meters from the B corner.

3. Starting at the B corner, use the measuring tape to measure a second side of your rectangle that is 8 meters long. Estimate the right angle for now. Put the C pin flag in the ground to mark the third corner.

4. Put another string between corners B and C. Make a mark on the new string that is 4 meters from corner B.

5. Have one group member take one end of the measuring tape and hold it on the mark on the string that is 3 meters from corner B. Another group member should walk to the other string and the mark that is 4 meters away from corner B.

6. Measure the distance between the two marks on the strings. If it is not 5 meters, have one group member go to flag C. Keeping the string tight, move the C flag from side to side until the distance between the two marks on the strings is 5 meters.

7. Use the same technique to lay out the two remaining sides of the rectangle.

THREE SCHOOLYARD ACTIVITIES FOR GPS RECEIVERS

Flag Finder

1. Before class, scatter between 6 and 12 coded pin flags around the school yard. 2. Write down the coordinates and letter code for each flag.
3. Students should have a data sheet and GPS. Have the students walk around the school yard and record the locations of as many pin flags as they can. Post the correct coordinates in the classroom and have students check their accuracy. Remember that tenths of seconds are important!

Testing GPS Accuracy

1. In the school yard, lay out several 30 meter measuring tapes running north-south, east-west, or both.
2. Stand at one end of a measuring tape and record your location with the GPS.
3. Walk to the 10-meter mark on the tape and record your location again.
4. Walk to the 30-meter mark and record your location again.
5. Use the data sheet to figure out how far the GPS said you were from the starting point at each location. Remember that each one-tenth of a degree is about 9 feet.

Where in the World is My School? Using Mapping Software

Assign groups of students a location in the school or on the school grounds. Have each group record the coordinates for places like the front door, a corner of the building, the library, the corner of the playground, or the principal s desk.
When students return, either download the data from the GPS receivers into the computer using a cable connection, or enter the coordinates of each location by hand.

Project the results on a screen. How accurate is the GPS?

EVALUATION:

Evaluate each student as they go through the activities. Students should be able to set up a density plot on the field trip and to locate one of the corners with a GPS receiver.

Students should be able to use their pace to find a distance with no more than 20 percent error.

Students will be able to lay out a rectangle with square corners.

Students should be able to accurately locate points with a GPS receiver and record the coordinates.

POTENTIAL RESOURCES:

http://www.state.de.us/planning/coord/dgdc/lessonplan1.htm

http://www.mercat.com/QUEST/Intro.htm

http://www.volunteertaskforce.org/lessonplans (PowerPoint presentation on GPS)

Name ____

Measuring the Earth from the Ground Up
Assessment Questions

Comprehensive Paragraph: Explain how latitude and longitude were calculated by 16th Century explorers and how they are determined in today s world.

Matching:

Latitude	a. a set of numbers that describes your location on or above the earth
Longitude	b. a global navigation system based on 24 or more satellites orbiting the earth at an altitude of 12,000 statue miles and providing very precise, worldwide positioning and navigation information 24 hours a day.
Coordinate	c. the degrees measure of how far east or west of the prime meridian a location is on Earth.
GPS Receiver	d. consists of the circuitry necessary to receive the signal from a single GPS satellite.
GPS	e. the degree measure of an angle whose vertex is the center of the Earth and one side is a radius to the equator. Used to indicate the location of a place with reference (north or south) to the equator.

True or False:

1. GPS can only be used on land and not on water (like an ocean) since water cannot be magnetized.
   a. True b. False

2. Since Global Positioning Systems (GPS) are a relatively new invention they are only accurate to within 100-500 feet.
   a. True b. False

Fill in:

1. GPS receivers are used in conjunction with ___________________ to determine latitude and longitude.

2. Latitude refers to distances north and south of the _______________.

3. Greenwich Meridian refers to the 0-degree of longitude. In which country is meridian located? _________________________.

ASSESSMENT TEACHER MASTER SHEET

Comprehensive Paragraph: Explain how latitude and longitude were calculated by 16th Century explorers and how they are determined in today s world.

Early explorers charted the skies: moon, stars, planets, in conjunction with horizon and season. Today location is measured with computer technology.

Matching:
Latitude e

Longitude c

Coordinate a

GPS Receiver d

GPS b

True or False:

1. GPS can only be used on land and not on water (like an ocean) since water cannot be magnetized. False

2. Since Global Positioning Systems (GPS) are a relatively new invention they are only accurate to within 100-500 feet. False

Fill in:

GPS receivers are used in conjunction with satellites to determine latitude and longitude.

Latitude refers to distances north and south of the equator.

Greenwich Meridian refers to the 0-degree of longitude. In which country is the meridian located? England

STUDENT SHEET

Flag Finder

Record the longitude and latitude of the pin flags:

A) N ______________ W ______________ E) N __________ W ______________

B) N ______________ W ______________ F) N ___________ W ____________

C) N ______________ W ______________ G) N __________ W ______________

D) N ______________ W ______________ H) N __________ W ______________

Testing GPS Accuracy

Coordinates of N ____________________

Coordinates at 10 meters: N__________________

the starting point: W ____________________

W ____________________

Each 1/10 degree equals 9 feet:

Distance you traveled north from start ______________________

Distance you traveled west from start ______________________

Coordinates at 30 meters: N ____________________

W ____________________

Distance you traveled north from start ______________________

Distance you traveled west from start ______________________

Where in the World is My School?

Where I took coordinates: __________________________________

Coordinates: N ____________________

W ____________________

PREPARING FOR THE FIELD TRIP: FIELD JOURNALS AND PHOTO COLLAGES

FOCUS QUESTIONS

How can we best organize the data collected on a field trip? What are the basics of taking a photograph that we can use to make a photo collage?

OVERVIEW OF LESSON PLAN

This lesson will prepare students for organizing their observations and data collected on the field trip. Students will prepare and organize a field journal the will include data sheets needed on the field trip. Students will learn how to organize observations made in burned and unburned forests by using a Venn diagram. Using basic photography skills, they will prepare for taking a series of photos in the field to use in creating a photo collage.

SUGGESTED TIME ALLOWANCE: 2 hours

LOCATION: Classroom

SUBJECT AREAS: Social Studies, Science, Language Arts, Technology

STUDENT OBJECTIVES

Students will:

- Create a field journal and understand the importance of keeping a well-organized record
- Understand how a Venn diagram can organize thoughts, observations, and feelings
- Learn basic photography techniques to use in a series of photographs for a photo collage

VOCABULARY

- Observations
- Venn diagram
- Joiners

MATERIALS

- Pencils
- Photocopied field journal sheets (provided at the end of this lesson) for each student, teacher, and chaperone
- One package blank paper and one package lined paper
- Colored paper, card stock or cardboard for journal covers
- Magic markers or colored pencils for decorating covers
- 3-hole punch
- String, binding tape, or twigs and rubber bands for binding
- Pencil on a string for each student
- Two plastic pencils sharpeners and extra pencils for field trip
- One box of large ziplock bags to rainproof journals

PROCEDURES

Creating Field Journals

1. Explain to students that field journals are an effective way to record and organize the many aspects of the information presented in this unit. Student journals can include writing, art work, data sheets, and general observations about their experiences in the field. Journals also provide a valuable assessment of student progress for teachers.

2. Distribute photocopies of all of the unit handouts and provide each student with double-sided copies. Use recycled paper if it is available. Provide five additional blank sheets of paper and five lined sheets of paper to each student.

3. Have students create front and back covers for their journals using blank sheets of paper.

4. Have students bind their journals using binding tape, hole punches and string, cardboard, or twigs bound by rubber bands threaded through holes. If they do not bind their journals, it is essential that students use a clipboard on the field trip.

5. Once journals are bound, have them decorate the covers. Have each student attach a sharpened pencil on a long string through a hole in the journal binding.

6. Have students use magic markers to write their names on the front covers of their journals.

7. Students will need a sturdy writing surface behind their field journals. Incorporate cardboard as the last page or have clipboards available for each student.

EXTENSION IDEAS

Create a journal that is used throughout the year.
Share student journals with parents at open houses and/or to educate others.
Students may choose to use their journals to create a class newsletter, resource newspaper, or a class website

Using a Venn Diagram to Organize Observations

1. Introduce students to the Venn diagram as a way to graphically organize their thoughts. Explain that the diagram is used to compare two objects, concepts, or even people.

2. After drawing a sample on the board, ask the students to draw two overlapping circles on a blank page in their field journals.

3. Ask students to identify the three areas defined in the drawing (two areas do not overlap and one area is the overlap between the two circles).

4. Explain that when comparing two things, some properties of each will be unique to that object, and that the two objects will share some characteristics. Relate this to the areas on the diagram.

5. Practice comparing two objects: friends, fruits, teachers, characters in a book, plants and animals, historic and modern forests, or surface and crown fires.

Basic Photography for a Photo Collage:

1. Write the following quote on the board: It takes time to see these pictures you can look at them for a long time, they invite that sort of looking. But more importantly, I realize that this sort of picture came closer to how we actually see, which is to say, not all-at-once but rather in discrete, separated glimpses which we then build up into our continuous experience of the word. David Hockney.

2. Share several of Hockneys photo collages (from internet resources or library books) with the class. Display a pre-made collage, not just prints and internet pictures. The ideas of a collage are more clearly seen when students can actually see and touch a collage.

3. Discuss with students why they think Hockney combined hundreds of photos for his compositions instead of just taking a single snapshot. What is unique about these compositions? What techniques of his can you use to develop your own collages?

4. Discuss what makes a good photograph. Some helpful tips are:
   - Shoot tight (close to your subject).
   - Be aware of what is in your background.
   - Watch that your fingers don t block the lens.
   - Hold the camera steady: squeeze the shutter button gently.
   - Surprise is an important ingredient in a good photograph. Photograph your subject from unexpected angles. Low angles can exaggerate the height of tall subjects or reveal unseen aspects. A shift in lateral position or any extreme viewpoint can also produce angles.

POTENTIAL RESOURCES:

http://www.ibiblio.org/wm/paint/auth/hockney

http://www.getty.edu/artsednet/resources/Look/Landscape/hockney.html.

http://www.mcs.csuhayward.edu/~malek/Hockney.html

http://www.artandculture.com/cgi-bin/WebObjects/ACLive.woa/wa/artist?id=262

Name________________________

Preparing for the Field Trip: Photo Collages
Assessment Questions

Comprehensive Paragraph: It has been written that photography is a means of visual communication, just like a word processor, telephone, or pen and paper can be used for correspondence. What is meant by visual communication?

Matching:

Joiners	a. The area seen by a lens or viewfinder; or the positioning of the subject in relation to the camera shot.
Background	b. All objects that come from behind the subject toward the camera.
Camera Angles	c. An artistic composition made of various materials (such as, paper, cloth or wood) glued on a surface.
Photo Collage	d. Arranging something into proper proportions, especially into artistic form.
Composition	e. To take many photographs, and piece the prints together to recreate the scene or person.

True or False:

Surprising the subject of a photo is never a good idea. The photographer should always allow the subject to get ready for the photo to eliminate blurriness and movement.

a. True   b. False

Never stand close to your subject. You always want to make sure you stand far enough away so you get the entire subject in the exact center of the frame.

a. True   b. False

Multiple Choice:

1. Photographing your subject from a low angle will make your subject seem
   a. taller than normal   b. shorter than normal
   c. closer to the bottom of the frame   d. further away than they appear

2. When taking a photo of an outdoor scene, one needs to design a plan before they actually start taking pictures; which of the following is the most important?
   a. unusual shape of the objects: (ie: trees)   b. color contrast
   c. shadow patterns/ landscape details   d. all of the above

3. When taking a photo outdoors during the daytime, where should the sun be positioned so your subject does not become silhouetted (darkened so badly you only see the outline of the subject)?
   a. behind the subject   b. to the left of the subject
   c. to the left of the photographer   d. behind the photgrapher

PREPARING FOR THE FIELD TRIP: PHOTO COLLAGES
ASSESSMENT TEACHER MASTER SHEET

Comprehensive Paragraph: It has been written that photography is a means of visual communication, just like a word processor, telephone, or pen and paper can be used for correspondence. What is meant by visual communication?

Any answer that the student develops some connection with visual responses, and how to apply these responses in a real-life situation. Students should realize that photography can be a teaching and learning tool.

Matching:
Joiners c
Background b
Camera Angles a
Photo Collage e
Composition d

True or False:
Surprising the subject of a photo is never a good idea. The photographer should always allow the subject to get ready for the photo to eliminate blurriness and movement. False

Never stand close to your subject. You always want to make sure you stand far enough away so you get the entire subject in the exact center of the frame. False

Multiple Choice:
1. Photographing your subject from a low angle will make your subject seem?
   a. taller than normal

2. When taking a photo of an outdoor scene, you need to design a plan before you actually start taking pictures; which of the following is the most important? d. all of the above

3. When taking a photo outdoors during the daytime, where should the sun be positioned so your subject does not become silhouetted (darkened so badly you only see the outline of the subject)? a. behind the photographer

EXPECTATIONS FOR FIELD JOURNALS

Reasons for keeping a journal:

To teach you about documentation

To help you be organized

To have a place for your comments, observations, thoughts, questions, and reflections

Items that will be recorded in your journal:

Data collection sheets

Brief notes on activities done in class

Observations and reflections

Notes on class discussions and reading done on your own

Assignments you are asked to do

Anything else you choose to write that is relevant to the topic being studied

Requirements and Expectations:

All journal pages should be numbered and both sides of the page should be used.

All journal entries should be dated (day, month, year).

All entries should be in pencil unless instructed otherwise.

Pages should never be torn out.

Journal entries should contain an interesting variety of writing styles, methods, and products including illustrations, pictures, and graphs.

Main ideas should be clearly presented.

Consistent use of appropriate science language and terminology should be present.

Effective use of models, diagrams, charts, and graphs should be utilized.

Journals should contain information on experiments (procedures used, actual data, analysis of data, and conclusions).

Entries should be well-organized, legible, and neat.

All notes and assignments should be completed on time.

Organization is important a reader should be able to follow what you have written.

All entries should be accompanied with a heading to indicate to the reader what the entry is about.

Evaluation of your journal:

Journals will be collected and graded in two week intervals.

You will be evaluated on:

1. Whether you have completed all of the assigned journaling prompts and if you have followed the above guidelines.
2. If your journal reflects a variety of thoughtful responses to the subject matter.

FIELD JOURNAL RATING SCALE

Rate as follows: 4 = Extends/Exceeds 3 = Practitioner 2 = Apprentice
1 = Novice NA = Not Applicable

1. Journal pages are numbered.	4 3 2 1 NA
2. Both sides of the page are used.	4 3 2 1 NA
3. Journal entries are dated (day, month, year).	4 3 2 1 NA
4. All entries are in pencil unless instructed otherwise.	4 3 2 1 NA
5. Pages are not torn out.	4 3 2 1 NA
6. Journal entries contain an interesting variety of writing styles, methods, and products including illustrations, pictures and graphs.	4 3 2 1 NA
7. Main ideas are clearly presented.	4 3 2 1 NA
8. Consistent use of appropriate science language and terminology is present.	4 3 2 1 NA
9. Effective use of models, diagrams, charts, and terminology is present.	4 3 2 1 NA
10. Journal contains information on experiments (procedures used, actual data, analysis of data, and conclusions).	4 3 2 1 NA
11. Entries are well-organized, legible, and reasonably neat.	4 3 2 1 NA
12. All notes and assignments are completed on time.	4 3 2 1 NA
13. Journal is organized.	4 3 2 1 NA
14. All entries are accompanied with a heading.	4 3 2 1 NA

Comments:

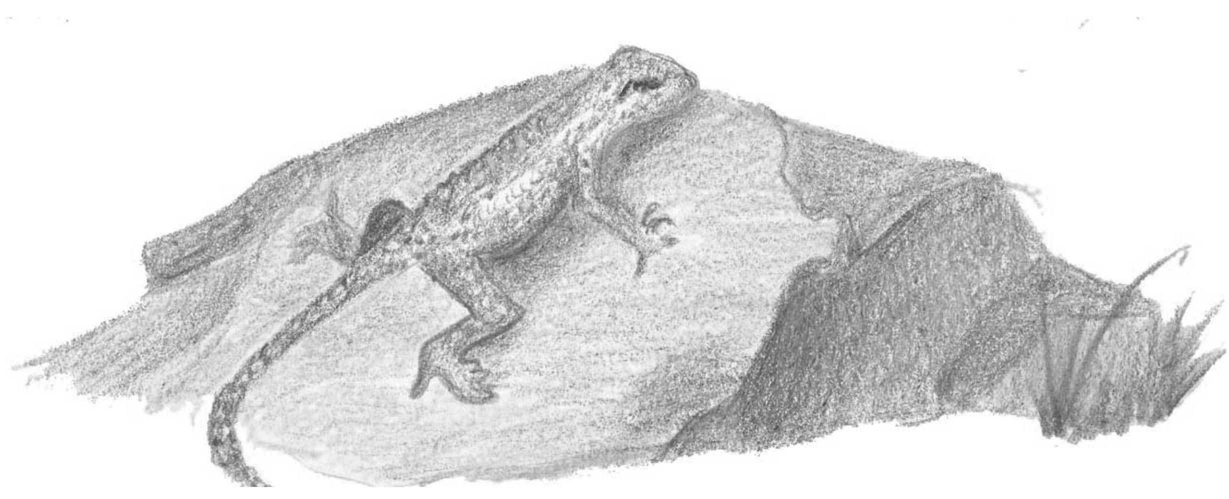
4 = Extends/Exceeds
The student consistently meets and at times exceeds (more depth/extension with grade level work and/or performing at a higher grade level) the standard as it is described the grade level key indicators. The student, with relative ease, grasps, applies and extends the key concepts, processes, and skills or the grade level.The work is the student s best effort.

3 = Practitioner
Student s work demonstrates solid academic performance. The student regularly meets the standard as it is described in the grade level key indicators. The student, with limited errors, grasps and applies the key concepts, processes, and skills for the grade level.

2 = Apprentice
Student s work demonstrates partial mastery of prerequisite knowledge and skills that are fundamental for proficient work at the grade level. The student is beginning to, and occasionally does, meet the standard as it is described by the grade level key indicators. The student is beginning to grasp and apply the key concepts, processes and skills at the grade level but produces work that contains many errors.

1 = Novice
Student s work is yet to demonstrate partial mastery of the knowledge and skills that are fundamental for proficient work at the grade level. The student is not meeting the standard as it is described by the key indicators for this grade level. The student is working on key indicators that are one or more years below grade level.

N A = Not Applicable
This particular concept has not yet been taught or is not yet ready for evaluation.

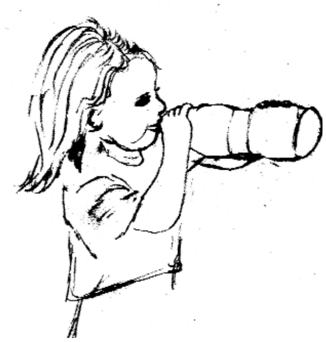


SAFETY

Safety is first and foremost. Safety concerns change as forest succession proceeds. In the early stages of succession, root burn-out and falling rocks are issues to be dealt with. As the trees begin to fall, hazard trees and ground litter become important. Other hazards are present regardless of the stage of succession: lack of water, poisonous plants and animals, rolling rocks, and tripping hazards. Below are outlined some hazards that should be discussed with the students before going into the field.

Safety Issues:

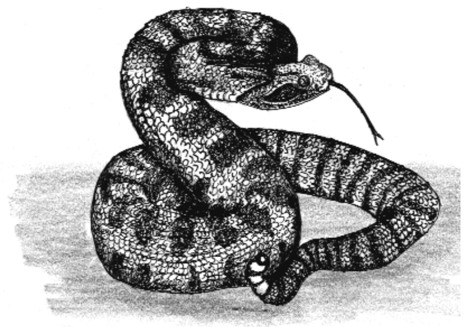
1) Sufficient Water: In this dry climate sufficient water is essential. Each student should bring approximately one quart of water, or water should be supplied by the field trip leader.



2) Sunburn: At high elevations the sun is intense. Sunscreen on exposed skin surfaces should be encouraged.

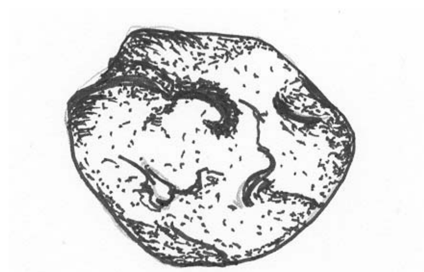
3) Poisonous Plants: Poison ivy causes rashes and sprouts after a fire. Leaves of three, let it be is a good motto.

4) Poisonous Snakes: Most snakes are not poisonous; however, the Prairie Rattlesnake can be present in forests. The best defense is moving the group away from any snake that is found. Do not kill any snakes.

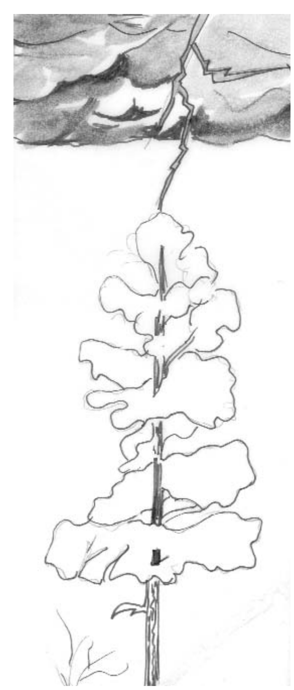


5) Hazard Trees: Trees that are leaning or have snapped off are considered hazard trees. Activities should not be done in a burned area when there are winds.

6) Rolling Rocks: Immediately after a fire there is not much vegetation to hold rocks on slopes. When a rock is loosened the student should yell Rock, warning anyone below them of the rock hazard.



7) Lightning: It is not safe to be on mesa tops or under trees during lightning storms. Lightning can strike you directly or indirectly through nearby objects. Take shelter in a building if a lightning storm arrives during your field trip.



Shrubs

- ❑ Gambel Oak Quercus gambelii
- ❑ Mountain Mahagony Cercocarpus montanus
- ❑ Gooseberry Ribes cereum
- ❑ Wild Rose Rosa woodsii
- ❑ Raspberry Rubus strigosus
- ❑ New Mexico Locust Robinia neomexicana
- ❑ Chokecherry Prunus virginiana

Subshrubs

- ❑ Kinnikinnik Arctostaphylos uva-ursi
- ❑ Mountain Lover Pachystima myrsinites
- ❑ Poison Ivy Rhus radicans

Invasive Plants

- ❑ Cheatgrass Bromus tectorum

Non-native Plants

- ❑ California Poppy
- ❑ Blue Flax Lenum levesii

Native Plants

RED FLOWERS:

- ❑ Indian Paintbrush Castilleja integra
- ❑ Scarlet Bugler Penstemon barbatus
- ❑ Scarlet Trumpet Ipomopsis aggregata

PURPLE FLOWERS:

- ❑ Gayfeather Liatris punctata
- ❑ Wild Onion Allium cernuum
- ❑ Townsend s Aster Townsendia incana
- ❑ Aster Aster app
- ❑ Daisy Erigeron app
- ❑ James geranium Geranium Caespitosum
- ❑ Beardtongue Penstemon Geranium Caespitosum

Yellow flowers:

- ❑ Goldenrod Solidago app
- ❑ Wild Chrysanthemum Bahia dissecta
- ❑ Snakeweed Gutierrezia sarothrae
- ❑ Pinque Hymenoxys richardsonii
- ❑ Mullein Verbascum thapsus
- ❑ Mustard Sisymbrium altissimum
- ❑ Rocky Mountain Bee-Plant Cleome serrulata

Weedy or green to bluegreen:

- ❑ False tarragon Dracunculus
- ❑ Chenopods Cheapodiaim app
- ❑ Sage Artemisia ludoriiciana

White flowers:

- ❑ Pussytoes Antennaria parvifolia
- ❑ Fleabane Daisy Erigeron divergens

Grasses

- ❑ Mountain Muhly Muhlenbergia montana
- ❑ Little Bluestem Andropogon scoparius
- ❑ Slender Wheatgrass Trachycaulum
- ❑ Bromus

Trees

- ❑ Limber Pine Pinus flexilis
- ❑ Ponderosa Pine Pinus ponderosa
- ❑ Aspen Populus Tremuloides

PLANT SCAVENGER HUNT OBSERVATIONS

Use this sheet to draw and label two native plants of your choice.

PLANT DATA INFORMATION

Common name refers to the name people in a region call the plant. Often these names express characteristics of the plant. Common names present a problem because the same name is often applied to more than one plant.

Scientific name refers to the name the scientific community has given to the plant.

Location refers to the specifics of where the plant was found.

Habitat refers to specific details of micro-habitat. Important points are type of soil or other substrate (sand, clay, granite, dead wood, other vegetation), associated species, moisture, and aspect (fully exposed on a south facing bank; in a damp hollow under dense scrub, etc.).

Description of plant includes everything about the plant that is not obvious on the identification sheet. Essential items are the height, type of bark, whether the stem is upright, sprawling or drooping, obvious smells, whether the plant is clumped, single or growing in patches, and the presence of creeping or underground stems. Flower and fruit color should also be noted as these often fade on dried specimens.

Surrounding vegetation also helps describe the site. For example Surrounded by scrub oak with an abundance of asters nearby.

Date refers to the day the plant is observed or collected.

PLANT DATA SHEET

Name of student: ______________________________ Date: __________

Common name of plant: ______________________________

Scientific name of plant: ______________________________

Location: ______________________________

Habitat: ______________________________

Surrounding vegetation: ______________________________

Description of plant:

PLANT DATA SHEET

Name of student: ______________ ______________ Date: __________

Common name of plant: ______________________________

Scientific name of plant: ______________________________

Location collected: ______________________________

Habitat: ______________________________

Surrounding vegetation: ______________________________

Description of plant:

Forest Plot Data Sheet

Thinned plot

Subplot number Date

Understory Sampling

Tree Number	Species (ponderosa pine unless noted otherwise)	Tree size DBH		Sample number	Percent Cover	Number of Species
1				1		
2				2		
3				3		
4				4		
5				5		
6				6		
7				7		
8				8		
9						
10				Average percent cover		
11						
12				Average species diversity		
13						
14						
15						
16						
17						
18						
19				Total number of		
20				of trees in subplot		
21						
22						
23				Number of trees in plot		
24				(subplot multiplied by 4)		
25						
26				Number of tree per acre		
27				(number in plot		
28				multiplied by 4)		
29						
30						
31						
32						
33						
34						
35						
36						
37						
38						

Forest Plot Data Sheet

Unthinned plot

Subplot number: ______ Date: ______

Tree Number	Species (ponderosa pine unless noted otherwise)	Tree size DBH
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
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22		
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24		
25		
26		
27		
28		
29		
30		
31		
32		
33		
34		
35		
36		
37		
38		

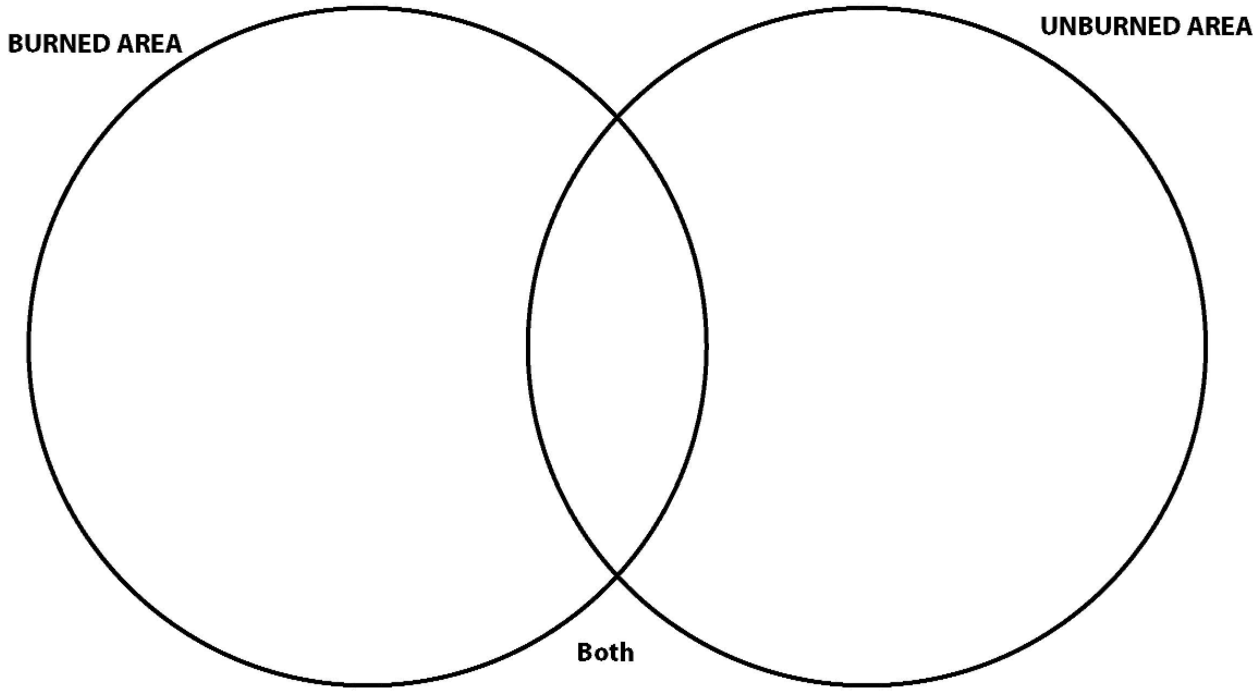
Understory Sampling

Sample number	Percent Cover	Number of Species
1		
2		
3		
4		
5		
6		
7		
8		

Average percent cover	
Average species diversity	
Total number of of trees in subplot	
Number of trees in plot (subplot multiplied by 4)	
Number of tree per acre (number in plot multiplied by 4)	

OBSERVATIONS IN BURNED AREA

Name:______________________________ Date:____________________



Investigating Fire Ecology

On-Site Activities

COMPARISION OF THINNED AND UNTHINNED FORESTS: PONDEROSA PINE FOREST STUDY PLOTS

FOCUS QUESTIONS:
What makes a healthy forest?

When wildfire strikes, why do some trees live while others die?

OVERVIEW OF LESSON PLAN:

This interdisciplinary field unit lesson combines mathematics, science, and language arts skills to discover and describe conditions and characteristics in thinned and unthinned sample plots in a ponderosa pine forest. These plots are an analog of pre- and post settlement forest conditions. In the classroom students will be introduced to basic fire ecology with an emphasis on local fire history.After classroom preparation lessons on fire, fire ecology, and measuring, in the field students will collect field data in a 20 x 50 meter ponderosa pine tree plot. They will divide this plot into 4 smaller rectangular sections 20 x 12.5 yards meters each. Working in teams, they will be counting, measuring diameter, and recording the number of pine trees they find in both the thinned and unthinned sections of forest. They also will be counting the number of different species in the understory of each plot. Students will enter their data in a database and submit a report summarizing their findings.

TEACHER BACKGROUND INFORMATION

On the field trip, students will collect the raw data necessary to evaluate forest health. In a post-trip classroom session, student will use the data to evaluate five indicators of forest health: number of trees per acre, average size of trees,the total tree basal area, and diversity of the understory.

Ponderosa Basics

Ponderosa pine (Pinus Ponderosa) is the most common and widespread pine in North America. A ponderosa pine can live 400-500 years. They grow to be 60 130 feet tall and up to 2 to 4 feet in diameter, depending on local conditions. The variety of ponderosa pine we have here usually has needles in bundles of three. The needles are 4 8 inches long the longest of any conifer (cone-bearing tree) in the Jemez Mountains. Sometimes the bark smells like vanilla! Ponderosa forests developed in this part of the southwest about 8,000 9,000 years ago,as the climate warmed at the end of the last ice age. These forests were open with individual trees or small clumps of trees, spaced widely apart (about 50 150 trees per acre). Locally, ponderosa pine forests grow from about 7,000 8,500 feet in elevation.

Humans in Ponderosa Pine Forests

Humans have lived in these forests for thousands of years. There are cavates in the cliffs on the north side of Rendija Canyon that are between 400 and 900 years old and a homestead on the mesa above them that dates back to the 1800s.

PONDEROSA FIRE ECOLOGY

Fire is a keystone ecological process in ponderosa pine forests of the southwest. It helped to shape and maintain these forests. Ponderosa pine is a fire-adapted species. These trees have thick bark to protect the tender growing tissue beneath. They lose their lower branches, so surface fires don t have a ladder to climb into the crowns. They have long needles to help protect the growing branch tips.

Prior to 1890, ponderosa pine forests had the highest fire frequency of all forest types found in the Jemez Mountains. Frequent, low-intensity surface fires burned through the grassy understory of these forests about every 7 10 years. These fires, mostly caused by lightning, kept the forest open, with trees widely spaced. These fires also recycled important nutrients. Then, around 1890, the fires just stopped throughout the southwest. This was due to the combined effects of overgrazing by livestock, high-grade logging, fire suppression, and climate. Grazing animals, especially sheep, ate all the grass that used to carry the fires. Without them, the forests became much denser and full of fuels for bigger, more destructive crown fires. Some of our ponderosa pine forests now have several thousand trees per acre!

Wildlife Habitat in Ponderosa Pine Forests Who Lives Here?
Deer, elk, mountain lions, squirrels, porcupines, hawks, songbirds, woodpeckers, bees, wasps, lizards can you name 3 others?

SUGGESTED TIME ALLOWANCE:
Class Time: 45 minutes, Field Time: 1.5 to 2 hours

LOCATION:
Rendija Canyon, Ponderosa Campground or other field site

SUBJECT AREAS: Language Arts, Social Studies, Science, Math, Technology

STUDENT OBJECTIVES
Students will:

Demonstrate mathematical skills by laying out a plot and measuring the diameter of the trees in two plots

Gain an overall understanding of how forest density affects wildfire behavior

Study the effects of wildfire on thinned and unthinned ponderosa pine forest stands and make quantitative measurements by comparing tree density and understory species of two comparable plots

Demonstrate mathematical skills by measuring the diameter of the trees and stumps in both plots

Collect and record scientific data in each identified plot

Describe qualitatively the characteristics of a healthy forest and an unhealthy forest

Gain an overall understanding of how forest density affects wildfire behavior

VOCABULARY

- Thinned
- Unthinned
- Competition
- Crown
- DBH
- Keystone process
- Biodiversity
- Fire suppression
- Ladder Fuels

MATERIALS AND RESOURCES

- Field journals
- Clipboards
- Pencils
- 8 aluminum corner stakes
- 4 300-foot rag tapes
- 6 100-foot rag tapes
- 8 rolls of surveyor tape
- 8 marking pens
- 8 diameter tapes
- 2 increment borers
- 8 pin flags, labeled T1-T4, U1-U4
- 8 three-foot ropes or plastic circles
- Forest Plot Datasheets
- GPS receivers
- Plot Sketch Data Sheets
- Computers
- Internet Connection (optional)
- Database/Spreadsheet software

PRETRIP PROCEDURES

1. In the classroom, students will learn about how grazing and fire suppression over the last 100 years have changed our forests. In the field, they will gather data from a healthy and unhealthy forest plot and compare tree density, ground cover, and species diversity to evaluate forest health.

2. As a class, students will brainstorm a list of what makes a healthy forest and what makes an unhealthy forest.

3. Divide students in groups of three or four, assigning each group the following questions:
   a. When wildfire strikes, why do some trees live and others die?
   b. What happened in the late 1800 s that contributed to crowded forest conditions?
   c. How has the ponderosa pine forest ecosystem changed over the past century?
   d. What differences do you think you will observe in the thinned plot and the unthinned plot?

4. Resume whole class discussion.

FIELD ACTIVITY PROCEDURES

Lay Out Plot

Instructors may want to line out the plots ahead of time.

1. Use the method practiced in lesson 4 to lay out two rectangular plots, one in a treated stand and the other in an untreated stand. The plots will bear 20 x 50 meters (approximately 1/4 acre). Mark plot corners with rebar or stakes.
2. Divide this plot into 4 smaller rectangular sections 22 meters by 12.5 meters each and mark the dividing lines with pin flags.
3. Label the flags for each subplot with a two-symbol code: U or T for thinned or unthinned, and a number from 1 to 4.
4. Use pin flags to identify the subplot section.
5. With a GPS receiver, find and record the coordinates for the corners of the plot.

Unthinned Plot Data Collection

Preliminary Observations

W rite down three things you notice about the plot. These can be things about the trees (height, density, color), the amount of bare soil under the trees, whether or not the tree crowns overlap, etc. Are there any signs of animals, birds, or insects living on or using the plot?

Mark and Number Trees

1. Record the plot number code on the data sheet.
2. Record relative locations and dimensions of all the trees in the subplot by making a sketch on the data sheet provided.
3. Tie colored flagging around each tree in the plot section. Include the stumps, if you are working on the thinned plot.
4. Use a marking pen to write a unique number on the flagging tied around the tree.
5. Measure the diameter of each tree at chest height (about 4.5 ft. above the ground). Record this number on the data sheet in the column marked DBH (diameter breast height).
6. Use the tape to measure the diameter of all trees in the subplot. Record each diameter on the flagging tied around each tree.

Map Trees

Use a pencil with an eraser for this part! Using the sheet with the outline of the plots, write the plot (thinned or unthinned) and section (1, 2, 3, and 4) on this map. Make sure to fill in the correct section. Work in teams. Move to one corner of the plot. Students can estimate the position within the plot rectangle of each tree in the plot. Use the tapes along the edges of the plot and the stakes at the corners as guides. Students then draw a circle on their the map for each tree. Write the tree s number next to the circle. Be careful to leave enough room on the map for all the trees.

Measure Trees

Measure the diameter of each tree at chest height (about 4.5 ft. above the ground). Record this number on the data sheet in the column marked DBH (diameter breast height).

Measure Stumps (Thinned Plot Only)

1. On the thinned plot, measure the diameter of all the stumps. Record this number on the data sheet.
2. Count the number of annual growth rings on the stumps. Record this number on the data sheet.

Biodiversity Indicators

1. Select a random patch of ground and spread out a loop of rope in a rough circle, or toss a plastic ring. Within the circle, estimate which of the following best represents the percent of ground surface covered by vegetation (as opposed to bare dirt): is it 0%, 25%, 50%, 75% or 100%. and record the estimate on the data sheet. Look at the plants within the circle and determine the number of different species present. (grasses, shrubs, wildflowers, etc.). Repeat 8 times at different locations around the plot.

2. Repeat the study for the thinned plot.

POST TRIP ACTIVITIES DISCUSSION AND ESSAY

1. Compare the number of trees per acre for subplot data and the entire plot. Are the numbers close? Which is more accurate and why?
2. Pre-settlement tree density in ponderosa stands averaged 70 to 100 stems per acre. Which of the two plots is more representative of historic forest conditions?
3. Ground cover and species diversity are measures of forest health. What does your understory data tell you about the forest health in unthinned and thinned pine forests?
4. Compare the distribution of size classes in the two plots. What conclusions about forest health can you draw from your observations?
5. Compare the volume of timber in each of the plots. What can you conclude about the thinning on tree and forest health?

EVALUATION:

Students will use forest density data collected on their field trip to analyze forest structure and compare pre and post settlement forests. Using their analysis and background, they will write a prescription for creating a healthier forest.

Student data should be complete with tree diameters, understory vegetation, and general observations recorded on their data sheets.

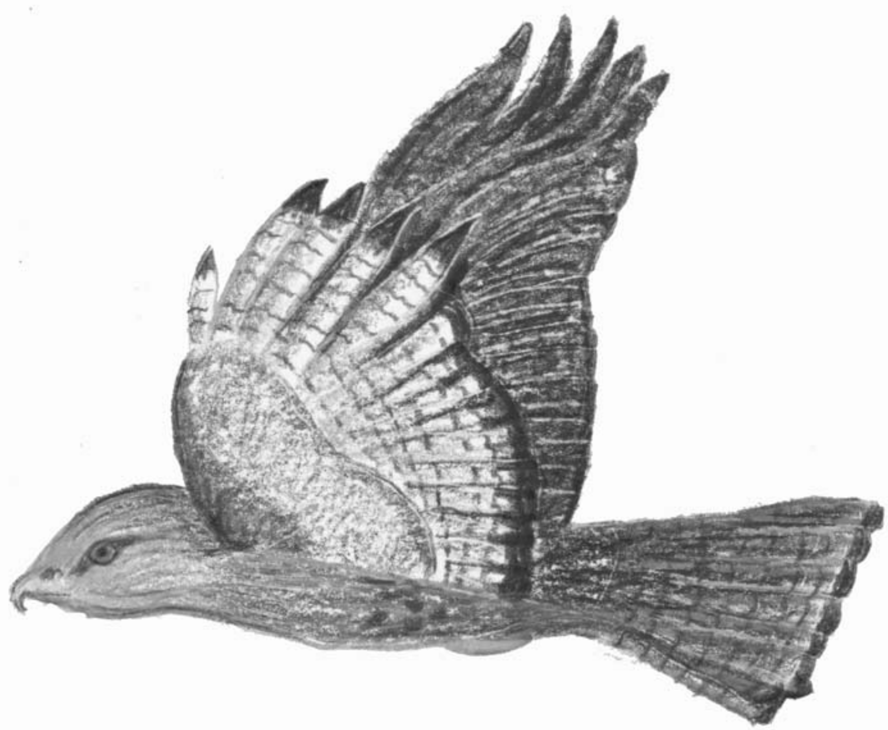
ON-SITE ACTIVITY

POTENTIAL RESOURCES:

http://www.greenforests.com/newsrel.html

http://www.wa.gov/dnr/htdocs/rp/stewardship/bfs/WESTERN/thinning

http://fire.nifc.nps.gov/fire/ecology/docs/construct.html



WILDFIRE AND NATIVE PLANTS: SKETCHING or PHOTOGRAPHING PLANTS

ON-SITE ACTIVITY

FOCUS QUESTIONS

What effect does wildfire have on plants?

What are the common types of plant species that inhabit an area after a forest fire?

OVERVIEW OF THE LESSON PLAN

This field lesson will introduce students to common plant species found in the region following a forest fire. On the field trip they will participate in a plant scavenger hunt and sketch or photograph selected common native plants. Back in the classroom, they will compile their research into a plant field guide. In order to ensure that this lesson is successful, the students will need to identify common plants via available resources in the classroom before going out in the field. It is advisable for the teacher to survey the area where plant observations are to take place before the students go out in order to find the most suitable location for collecting plants. The plants listed in this guide are most common in late summer and early fall in the Los Alamos area. (NOTE: Be sure NOT to collect or disturb any species which may be endangered or at risk).

SUGGESTED TIME ALLOWANCE: 1 hour

LOCATION: Rendija Canyon or other field site (not Ponderosa Campground)

SUBJECTS: Science, Language Arts , Math, Art, Technology

STUDENT OBJECTIVES

Students will:

- Use keys and plant cards for plant identification
- Develop plant observation, identification and classification skills.
- Use the handout, Plant Scavenger Hunt Check List and look for as many identified plants as time allows.
- Use the Plant Scavenger Hunt Observation sheet to draw and label two native plants of their choice. (See also photographing & collecting)
- Become more sensitized to and appreciative of the flora around them.

VOCABULARY

- Forest succession
- Adaptation
- Serotinous
- Phyrophytes
- Endangered species
- Native plants

ON-SITE ACTIVITY

FIELD MATERIALS

- Science journals
- Field guides of regional plant life
- Colored pencils
- Cameras
- Plant scavenger hunt check list
- Plant scavenger hunt observation sheet
- Plant identification cards
- Plant data sheets

PROCEDURES

1. PLANT SCAVENGER HUNT

a. Review safety rules.
b. Pair students in teams of 2-4.
c. Using the plant scavenger hunt check list and plant identification cards find as many plants as time allows.

2. FIELD SKETCHING

Introduce field sketching as part of both science and art. Many students will be apprehensive about drawing, and claim that they can t draw. This is just not true. The importance of field sketching is in conveying information, and allowing the sketcher an in-depth understanding of the object sketched. Sketching can improve observation, patience, and hand-eye coordination, as well as increase knowledge of how things are put together, how they function, and where they live.

1. Have students work in teams of 2 4.
2. Give students a choice of plants they may sketch.
3. Spend at least 2 minutes just observing their plant before they begin drawing.
4. Drawing by memory: Have students observe the plant, then try and draw it from memory. This is a skill that all sketchers would like to perfect because they could then be formulating drawings in their heads all the time. Have students try a few of these before they look at their plant again.
5. Contour drawing: This time, have students look only at their subject, and NOT at the paper. Have students place their pencils on the paper and NOT lift them up until they feel they are finished. Draw all the ins and outs, not just the outline. These drawings may be really funny looking but for new students of sketching, they will often show some of the best observing and line use.
6. Quick gesture sketch: Have students look at both the plant and the paper simultaneously. No erasing allowed!! This type of sketching was common for artists like Michelangelo, Picasso and Van Gogh. Gesture sketches should loosen up hands and fingers. Keep these sketches under 10 seconds.
7. Diagrammatic sketches: Basically a line drawing like those seen in field guides. Have students write details next to the drawing, like hair stem, pinkish petals, found near a burned tree in Los Alamos, NM and the date. Spend about 5 minutes on this drawing.

8. Draw only part of the plant.
9. Study drawing: A complete drawing. Spend about 15 minutes to 45 minutes. Include shading

(Reference: Leslie, C.W. (1995). The Art of Field Sketching)

3. PHOTOGRAPHY

Handling a camera with skill and ease may make the difference between getting a sharp picture or getting one that s fuzzy. It s important that the photographer doesn t fumble with the camera, doesn t focus improperly, or jiggle the camera as the shutter release is pressed. It is recommended to practice without film first to develop good camera handling habits.

1. Have students work in teams of 2-4.
2. Give students a choice of what plants they may photograph.
3. Make sure the camera lens is clean.
4. Hold the camera steady in order to obtain sharp pictures.
5. Explore different camera angles to determine the best composition and the most creative approach. Shoot down to create attractive pinwheel patterns of daisies; kneel to the level of other flowers.
6. Use a simple background. Find a position that provides a plain, non-competing background. Or place a black or pleasingly-colored cardboard behind the flower.
7. Move close to your subject (plant) for dynamic photos with impact. With a digital camera, use the display screen to compose the picture.
8. Use creative lighting. Observe the lighting on your plants. Backlighting shining through some flowers gives them an appealing glow. Cloudy-day lighting reveals subtle hues.

(Resource: Adapted from the Kodak website http://www.kodak.com)

4. PLANT COLLECTING

(not an option at Ponderosa Campground in Bandelier National Monument - items may not be collected anywhere in the park)

Discuss the ethics of plant collecting.

When collecting plants you may find yourself hesitating because you don t want to alter or disturb the particular habitat in which you find them. You always have to weigh the educational value of the collection against the impact of removing the parts of the plant. Make sure there is enough of the desired plant in your area. If you only see two, the plant should be left alone. If you see 10 that s a reasonable number to work around. You should be familiar with any sensitive, threatened, or endangered species you might encounter. Only take enough of the plant to serve the needs of your lesson. Never pick more than a third of a plant. If it is a solitary bush or tree, remove just a few twigs and leaves from the outer edge. Small pruning shears work well for a cutting tool. Wildflowers have a slower reproduction rate and grow much more slowly than other types of plants. Collecting or disturbing could affect their survival. Use your best judgment. If they are in their seeding mode, collect the seeds from only a couple of plants and leave the rest. Collect plants when the dew has dried and the flowers are fully opened. Be sure to collect enough length of the plant to show several leaves, flowers, and fruits.

Before going on to private land, get permission. Collecting is illegal in city, county, state, and national parks. Collecting is allowed in most national forests and grasslands and state-owned wildlife and waterfowl production areas. You should always seek permission from the state agencies first.

Introduce common plants students may find in the field by showing them pictures or making overheads from sketches. Ask students if they can identify these or know of any other species they may find.

1. Direct teams to specific collection areas with the following materials: pruners or scissors, coffee filters for collecting plants, pencils, data sheets, guide books, or copies of plant identification handouts.
2. Have students collect up to 10 samples, each of different plants they find.
3. It is very important to keep careful records when collecting plants. Plant names do not have to be known at the time of collection they can be looked up later. Data should contain common name of plant, scientific name of plant, location collected, growing site, habitat, surrounding vegetation, name of collector, date, general description. (See plant collecting data form).
4. To get successful results from pressing, it is important to pick and then store the plants properly while you are still in the field. Ideally it is best to press them on location. Good botanical specimens deteriorate quickly. If practical, press plants in an old phone book or plant press on site. Paper coffee filters work temporarily, so students can carefully store their plants until they return to the classroom. Small plants can be placed singly, or two or three together if necessary. Plastic bags are not recommended because the risk of damaging the specimen is very great. A small sticky note with the plant name placed with the plant will help students with identification later.
5. If they haven t already done so in the field, students should press their plants as soon as they return to the classroom.

PRE-TRIP

Students should complete lesson 3 in the classroom, and review the special safety rules below.

SAFETY IN THE FIELD FOR PLANT COLLECTION

1. Survey the study site for potential hazards before taking your class out.
2. Define boundaries of the study site. Make sure students know these boundaries. Consider using brightly colored engineer stape to mark boundaries.
3. Check for the presence of large amounts of bees or wasps around the plants you want to sketch or photograph.
4. Warn the students never to eat any plant or plant part.
5. Check for allergies and asthma with your students and on their school medical cards.
6. Always have a backpack with a first aid kit and preferably a cell phone or other communication device with you in the field.
7. Refer to attached safety sheet for general safety tips.

PROCEDURE ON HOW TO PRESS PLANTS

(If using collected plants for the field guide follow this procedure)

Layered Paper Method

1. Make sure the plant is clean and dry.
2. Arrange the specimens on two layered sheets of absorbent paper. Make sure all plant parts are spread out to show them off. Make sure your plant pressing area is on a flat, dry, hard surface in a warm, dry room.
3. Put two or three sheets of paper on the plant(s). Add more plants to top sheet, layer three more sheets on top and so on up to ten layers (otherwise it becomes too unwieldy).
4. On the top three layers of paper, add books or bricks to cover paper. Make sure there is sufficient weight to exert enough pressure on plants. Pile should yield to weight.
5. Change sheets every two or three days. It will take the plants one to two weeks to dry completely.
6. They will be very brittle so handle with care.

Phone Book Method

1. Place plant specimens randomly in phone book so they are evenly distributed.
2. Place tissue paper on both sides of the specimen.
3. Use post-it notes to bookmark and record common name.
4. Place weight on top of phone book and leave until thoroughly dry.

OBSERVATIONS OF BURNED AND UNBURNED FORESTS

FOCUS QUESTIONS

How can I use my senses to help me understand burned and unburned forests?

How can I look at a burned forest and take photographs of what the burned forest means to me?

OVERVIEW OF LESSON PLAN

This field trip lesson challenges students to make observations in burned and unburned forests, to express their observations and feelings in writing and in a photo collage in the style of David Hockney. From notes taken on the field trip, they will compose an essay or a poem. Using basic photography skills, they will take a series of photos in the field to use in creating a photo collage.

SUGGESTED TIME ALLOWANCE: Class Time: 1 hour

LOCATION: Rendija Canyon or other field trip location

SUBJECT AREAS: Language Arts, Fine Arts, Technology

STUDENT OBJECTIVES

Students will:

- Use more than just sight to make observations about burned and unburned forests
- Organize their observations with a Venn diagram
- Locate visual images that express their feelings of burned forests and organize photos of those images into a collage
- Learn basic photography techniques
- Find an interesting forest landscape and experiment with composition and transformation

MATERIALS

Writing exercise

- Pencils
- Field journals
- Clipboards
- Disposable cameras or digital

Photo collages

- Disposable cameras (color 26 exposure)

PROCEDURES

Writing exercise

Find a location in an unburned section of forest. Have the students sit down, get comfortable, and get out their clipboard with the Forest Observation Sheet. Working alone (at least at first), have the students start making and recording observations. They should record their observations in the Unburned Area circle in the Venn diagram on the observation sheet, and add any more details they wish to record in the space below. Have them record at least 10 observations, with at least one for hearing, smelling, and touching.

Some observations that might be made are the amount of vegetation, kinds of vegetation, height of vegetation, the number of different plants that are growing, the feel of the soil, the sound of the wind, odors, and the colors in the forest.

After about 10 minutes, walk down a road or trail to find an area of severely burned forest. Sit again and have the students repeat the observation process. Have them record what is unique about the burned area in the Burned Area circle on the Venn diagram. If they find observations that are common to both burned and unburned forest, they should record it in the intersection of the two circles.

Photo Collages

Before you start, it s a good idea to practice taking pictures with a cardboard viewfinder, or shaping your fingers into a box .

With a partner, students will take a series of 24 pictures (12 each) that can be assembled into a collage in the classroom.

1. One student needs to take a picture of the other so they can identify their pictures after they are developed.

2. In a section of burned forest students should look for areas that have been severely burned, moderately burned, or areas of regrowth.

3. Emphasize to students the need to spend time designing a plan before they actually start taking the photographs. Have them look for interesting features, such as unusual shapes of trees, color contrast, shadow patterns and landscape details. People are not to be in the pictures.

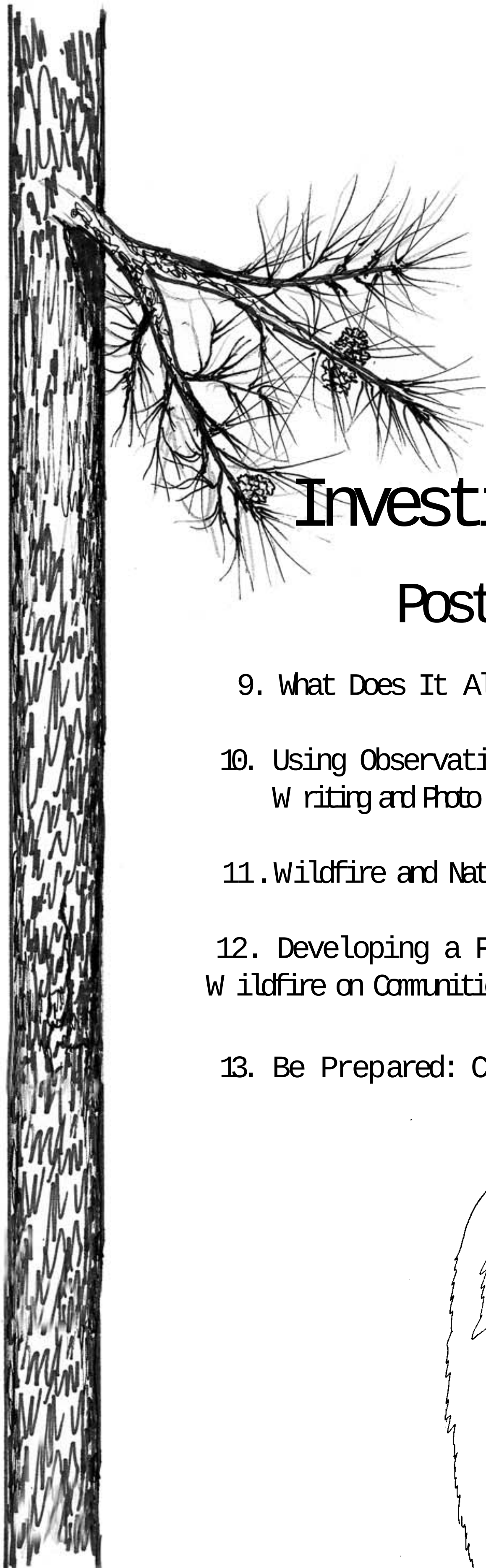
4. With their partner, students need to find a suitable area and then select a specific spot on the ground. They will stand on this spot and begin shooting a series of pictures so that when developed, they will overlap slightly. Remind them to avoid horizontal and vertical gaps between photos.

5. Holding the camera level, and very still, one student will carefully take 13 pictures. He/she will then hand the camera to their partner in the exact same position and continue with the remaining 13 pictures. The area covered is comparable to a semi-circle.

6. If they wish to design their collage vertically instead of horizontally, they can use the same procedure, just aim the camera differently. When finished instruct students to put the camera inside their backpack.

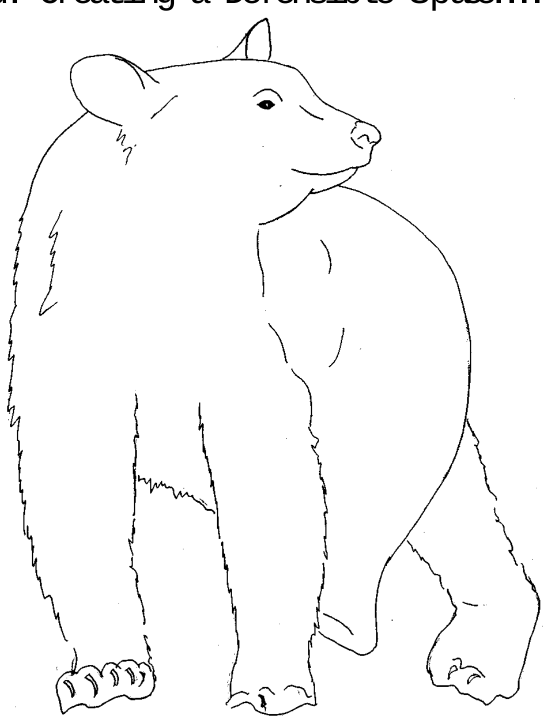
Evaluation

Students will produce a writing sample and a photo collage in the classroom. Students will be evaluated on photo composition, participation in class discussions, cooperation with their partner, and completed photo collages.



Investigating Fire Ecology

Post-Field Trip Lessons



WHAT DOES IT ALL MEAN? POST-FIELD TRIP DATA ANALYSIS OF FOREST DENSITY PLOTS

FOCUS QUESTIONS

How can we quantify a healthy and an unhealthy forest?

How can we use data to create a healthier forest?

OVERVIEW OF LESSON PLAN

This interdisciplinary unit combines mathematics, science, and technology. Students will use forest density data collected on a field trip to analyze forest structure and compare pre- and post-settlement forests. Using their analysis and background, they will write a prescription for creating a healthier forest.

SUGGESTED TIME ALLOWANCE:

Class Time: 2 hours

LOCATION:

Classroom or computer lab

SUBJECT AREAS: Language Arts, Social Studies, Science, Math, Technology

STUDENT OBJECTIVES

Students will:

- Demonstrate mathematical skills by calculating forest density on two plots
- Analyze scientific data collected in the field
- Describe quantitatively the characteristics of a healthy forest and an unhealthy forest
- Use their findings to make a recommendation for thinning a dense forest stand

VOCABULARY

- Thinned
- Unthinned
- Competition
- Biodiversity
- Diameter breast height (DBH)
- Tree basal area

MATERIALS

- Pencils
- Forest Plot Data Sheets
- Calculators
- Computers and spreadsheet software (optional)

Post-Visit LESSON PLAN

PROCEDURES

Data Analysis

For this study, students can use either the data their group collected on the field trip, or use data provided on the enclosed data sheets.

1. Calculate the number of trees per acre on thinned and unthinned plots.
   a. Count the number of trees on the thinned subplot and enter the value on the data sheet. Multiply the number of trees by four to find the estimated number of trees on the entire 50-meter by 20-meter plot, and record the number. Because each plot is about 1/4 acre, multiply the number of trees on the entire plot by four to find the number of trees per acre. Record the answer on the data sheet.
   b. Repeat the calculation of trees per acre for the unthinned plot.
2. Calculate the average diameter of the trees in the plot.
   a. Use a calculator to add up all the tree diameters in the thinned subplot. Divide the answer by the number of trees on the subplot to find the average diameter. Record the answer on the data sheet.
   b. Use a calculator to add up all the tree diameters on the unthinned subplot. Divide the answers by the number of trees on the subplot to find the average diameter. Record the answer on the data sheet.
3. Estimate the area of the thinned subplot that is covered by tree trunks, which is called the total basal area of trees.
   a. Use the average diameter of the trees to find the average basal area. To do this, first find the radius of the average tree (r) by dividing the average diameter by 2. The average basal the area of trees is:

      Tree Basal Area= 3.1 x r x r

      Multiply the average area by the number of trees in the subplot to estimate the total basal area. Record the answer on the data sheet.

   b. Use the same calculations to find the total basal area on the unthinned plot. Record the answer on the data sheet.

4. Calculate the average percent cover for the thinned and unthinned subplots and record the answer.

5. Calculate the average number of species for each subplot and record the answer.

QUESTIONS FOR CLASS DISCUSSION

1. Compare the number of trees per acre for subplot data and the entire plot. Are the numbers close? Which is more accurate and why?

2. Historic tree density in ponderosa stands averaged 70 to 100 stems per acre. Which of the two plots is more representative of historic forest conditions?

3. Ground cover and biodiversity are measures of forest health. What does your understory data tell you about the forest health in unthinned and thinned pine forests?

4. Compare the distribution of big and small trees in the two plots. What conclusions about forest health can you draw from your observations?

5. Make a statement about which forest stand is healthier. Support your statement with 5 observations you can make from the data.

6. In the thinned forest, the age on one tree with a 10-inch diameter is 80 years. In the unthinned forest, one tree with a 4-inch diameter is 85 years. Explain how this could happen.

Thinning Plan

Working with a group, look at the plot sketch on the Forest Plot Data Analysis Sheet. Decide if there are too many trees on the plot. If so, design a recommendation on how to make the forest healthier. Include instructions on how many trees should be removed from each acre. On your sketch of the unthinned plot, mark in red the trees you would recommend be removed. Justify your decisions on how many trees should be taken out, how many should remain, which trees should stay and which should be removed. Present your recommendations to the class.

EVALUATION

Students will be evaluated based on complete and detailed data analysis sheets, participation in class discussion, and an informed presentation based on their data analysis.

POTENTIAL RESOURCES

http://www.greenforests.com/newsrel.html

http://www.wa.gov/dnr/htdocs/rp/stewardship/bfs/WESTERN/thinning

http://fire.nifc.nps.gov/fire/ecology/docs/construct.html

What does it all mean?

Forest Plot Data Sheet — Unthinned plot

Subplot 1

Tree	Tree circumference	Tree DBH	Tree basal area
1	13.7		
2	13.3		
3	20.6		
4	23.4		
5	21.3		
6	18.9		
7	17.5		
8	23.1		
9	24.8		
10	17.5		
11	13.4		
12	18.7		
13	19.6		
14	20.2		
15	18.5		
16	7.2		
17	11.8		
18	15.6		
19	22.2		
20	27.7		
21	9.8		
22	6.2		
23	7.5		
24	15.6		
25	17.2		
26	25.8		
27	71.3		
28	27.4		
29			
30			
	Total		

Total number of of trees in subplot	
Number of trees in plot (subplot multiplied by 4)	
Number of trees per acre (number in plot multiplied by 4)	
Average diameter of trees	
Total basal area of trees	

Understory Sampling

Sample	% cover	# of species
1	5	1
2	15	1
3	75	4
4	50	3
5	100	1
6	60	1
7	75	2
8	100	4

Average percent cover	
Average species diversity	

QUESTIONS

1. Make a statement about which forest stand is healthier. Support your statement with 5 observations you can make from the data.
2. In the thinned forest, the age of one tree with a 10-inch diameter is 80 years. In the unthinned forest, one tree with a 4-inch diameter is 85 years. Explain how this could happen.
3. Write a recommendation on how to make the unthinned forest healthier. Include instructions on how many trees should be removed from each acre. On your sketch of the unthinned plot, mark in red the trees you would recommend be removed.

What does it all mean?

Forest Plot Data Sheet

Subplot 1

Tree	Tree circumference	Tree DBH	Tree basal area
1	31.9		
2	42.1		
3	38.8		
4			
5			
6			
	Total		

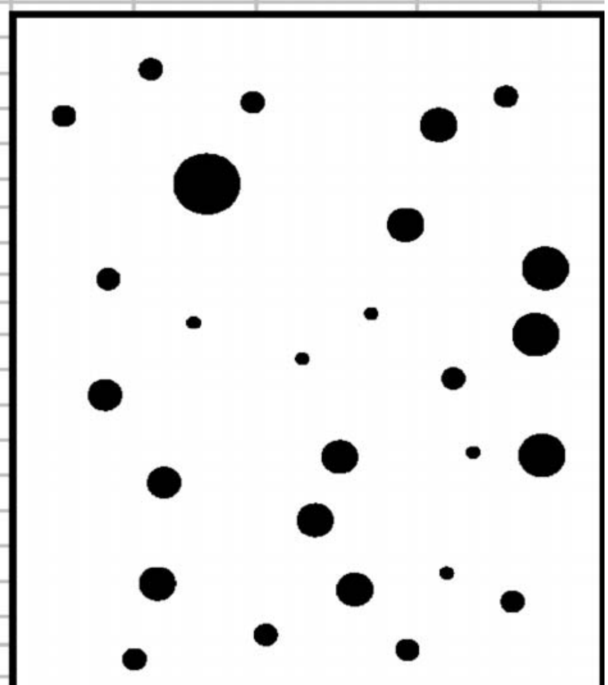
Total number of trees in subplot	
Number of trees in plot (subplot multiplied by 4)	
Number of tree per acre (number in plot multiplied by 4)	
Average diameter of trees	
Total basal area of trees	

Thinned plot

Understory Sampling

Sample	% Cover	# of species
1	0	0
2	35	2
3	0	0
4	75	1
5	15	5
6	0	0
7	25	1
8	50	1

Average percent cover	
Average species diversity	



Unthinned plot sketch

EXPRESSING PERSONAL FEELINGS BASED ON OBSERVATIONS OF BURNED & UNBURNED FORESTS

FOCUS QUESTIONS

How can I express my feelings about the forest, both unburned and burned?

How can we create a forest landscape using photographic joiners in the style of David Hockney?

OVERVIEW OF LESSON PLAN

In the classroom, students will use the observations they made on the field trip in burned and unburned forests, then to express their observations and feelings in writing and in a photo collage in the style of David Hockney. From notes taken on the field trip, they will compose an essay or a poem. Using basic photography skills, they will design a photo collage from photos taken in the field.

SUGGESTED TIME ALLOWANCE: Class Time: 3 hours

LOCATION: Classroom, art room, computer lab (optional)

SUBJECT AREAS: Language Arts, Fine Arts, Technology

STUDENT OBJECTIVES

Students will:

- Express their observations and feelings in writing
- Research and study the works of David Hockney
- Communicate values, opinions, and personal insights through an original work of art
- Learn basic photography techniques
- Identify and describe the principles of design in visual compositions, emphasizing unity and harmony
- Learn perspective and planning techniques
- Assemble a quality photo collage using the style of David Hockney
- Work collaboratively sharing opinions and planning designs

MATERIALS

Writing exercise

- Pencils
- Field trip observation sheets
- Disposable cameras
- Computers and spreadsheet softwareword processing software (optional)

Photo collages

- Online or library resources on information about David Hockney
- Disposable cameras (26 color exposure)
- Workstation that allows space to spread photos out
- Masking tape

Rub-on glue sticks
Cardboard viewfinders, (optional for practice)
Photo quality paper for mounting photos
Framing materials (optional)

PROCEDURES

Writing exercise

1. Have a class discussion about what the students observed in the burned and unburned areas. What was unique about both areas, and what characteristics did they share? Encourage the students to talk about how the burned forest made them feel. Are they hopeful, saddened, threatened, or able to see beauty there?

2. Working alone, have the students write one of the following forms, using their observation sheets as a starting point.
   a. Write a compare and contrast essay
   b. Write a pair of haiku to compare the areas
   c. Write a pair of diamantes to compare the areas
   d. Write a cinquain that summarizes their experience in the field
   e. Write an acrostic on the trail they walked along, the fire that they studied, the name of where they live, or on PONDEROSA PINE.

3. After working through rough drafts, have the students publish their essays or poetry. Have each student enter their work into a word processing application. Students should choose a font that they believe best suits their words. Make a collection of the student work for a classroom portfolio.

Photo Collage

1. Develop film (4 x 6 double prints on a matt surface).

2. Return one set of prints to the student teams. (Extra set can be used as a backup or another collage).

3. Have students design their composition by laying out the photos so there is a slight overlap.

4. Before gluing, students should lightly tack each photo in place using masking tape.

5. When the design is approved students will carefully glue the photo to the paper.

6. A completed collage can be mounted and framed if desired.

EXTENSION ACTIVITIES

Create an exhibit of work in the local library or other public place.
Demonstrate how history, art, and culture can influence each other in making and studying works of art.
Visit museums and art displays.
Incorporate the use of at least one means of technology in creating an original work of art. For example use digital cameras in place of disposable cameras.

EVALUATION

Students will produce a writing sample and a photo collage. Students will be evaluated on photo composition, participation in class discussions, cooperation with their partner, and completed photo collages.

POTENTIAL RESOURCES:

http://www.artchive.com/artchive/H/hockney.html

http://www.ibiblio.org/wm/paint/auth/hockney

http://www.getty.edu/artsednet/resources/Look/Landscape/hockney.html

http://www.mcs.csuhayward.edu/~malek/Hockney.html

http://www.artandculture.com/cgi-bin/WebObjects/ACLive.woa/wa/artist?id=262

WILDFIRE AND NATIVE PLANTS

DEVELOPING A FIELD GUIDE FOR NATIVE PLANTS

FOCUS QUESTIONS

What effect does wildfire have on plants?
What are the common types of plant species that inhabit your area after a forest fire?

OVERVIEW OF THE LESSON PLAN

In the classroom, students will refer to the plants they identified in the field and add information from other plant sources to complete their native plant field guide.

SUGGESTED TIME ALLOWANCE: 4 hours

LOCATION: Classroom

SUBJECTS: Science, Language Arts, Math, Art, Technology

STUDENT OBJECTIVES

Students will:

- Complete plant data sheets for plants identified in the field.
- Create personalized plant field guides.
- Become familiar with utilizing commercial field guides and other resources.

VOCABULARY

Forest succession	Native plants
Adaptation	Phyrophytes
Serotinous	Endangered species

MATERIALS

- Websites, books, newspaper articles, encyclopedias
- Pictures of common regional plants
- Student s sketches and/or photographs of plants
- Plant data sheets
- Science journals
- Field guides of regional plant life
- Computer with internet and data base access
- Card stock, tag board, or other heavy paper
- Colored pencils
- Ruler
- Scissors
- Glue
- Hole punch
- Ribbon or yarn
- Black felt tip pen for outlining
- Misc. art supplies

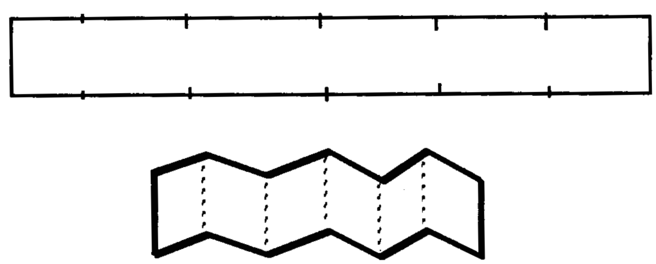
PROCEDURES

1. PLANT DATA SHEET
Students will look up information on plants identified in the field in plant resource books or internet sources and complete the plant data sheet.

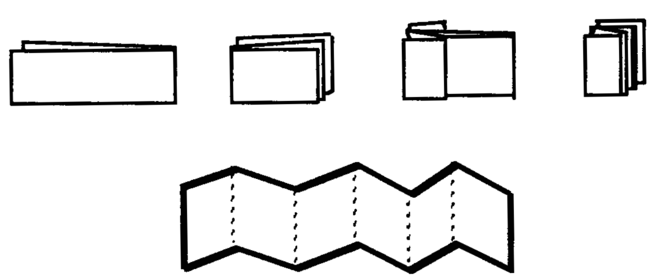
2. CREATING A FIELD GUIDE FOR NATIVE PLANTS
Field guides are books that contain photographs or accurate illustrations along with clear descriptions of plants. These guides are used by scientists, students and amateurs to help them identify species which they encounter but are unable to recognize. It is an essential tool in helping students identify plants they sketch, photograph, or collect.

There are many different ways to make a field guide. One approach is to make an accordion book. The zigzag shaped fold is best made with heavy paper, card stock tag board, preferably acid free. The stiff paper stands up well for a dramatic visual arrangement. Accordion books are easy to make and result in an interesting form for writing or drawing.

1. Method 1: Measuring
Carefully measure and mark equal page sections. Fold on the marks. Be careful to make the edges match perfectly.



2. Method 2: Folding
Fold in half repeatedly. Begin with the full length of the paper and fold in half perfectly. Next, fold each half in half, folding the edge back toward the center. Then fold each section in half again. As you fold, always watch that the edges match. Continue folding in half, then quarters, eighths, and sixteenths until the pages are the desired width.



3. Draw or glue plant photographs on paper. If using actual pressed plants lightly tack the plant specimen to the paper with Elmer s glue. Students can mix glue and water together in a shallow container, then apply with a small paint brush. Think sparingly, there is no need to coat the entire back of the plant with glue. Pre-cut clear contact paper slightly larger than the plant and carefully place it over the plant.
4. Write the information from the plant data sheet next to the plant. Check the data sheet beforehand for spelling accuracy.
5. Leave the front section for the cover.
6. Punch a small hole to insert a ribbon or piece of yarn to tie the finished guide together.

EVALUATION

Students will be evaluated on completed plant data sheets, participation in class discussions, participation in group work, and creation of a field guide of native plants.

POTENTIAL RESOURCES

http://www.northmason.wednet.edu/HMHSonline/student_gallery/fire/c...

http://pictures.discovery.com/dppages/wildfire/teacher/lesson1.html

http://horizon.nmsu.edu/ddl/pltcollguide.html. http://biology.arizona.edu/sciconn/lessons2/Barber/PCDForm.htm

Collecting and Preserving Plants by Ruth B. (Alford) MacFarlane Dover Edition 1994 ISBN: 0-486-28281-3

Botany in a Day by Thomas J. Elpel 4th Edition ISBN: 1-892784-07-6

Flowering Plants of the Southwestern Woodlands by Teralene Foxx and Dorothy Hoard 1995 ISBN: 0-9645703-1-9.

EXTENSION ACTIVITIES

1. Invite speakers, such as the county extension agent, local nursery staff, master gardeners, and horticulture experts to share information with students.

2. Create a herbarium for your school. The purpose of a herbarium is to preserve specimens and share with others. Herbariums can be placed in a very visible place in the school office, library, or cafeteria.

3. Students can divide the preserved plants according to a category (e.g. habitat, medicinal or dye use, food, or woody, herbaceous, etc.) In cooperative groups they can create a presentation about their plant group. They can do a puppet show, an overhead presentation, or a computer presentation.

4. Research non-native invasive plant species on both disturbed and undisturbed sites.

5. After students have identified plants on the field trip have them choose a favorite species which they can research in greater depth.

6. For a science fair project study forest fire succession of plants. Identify different species of plants after a forest fire has occurred by counting the numbers of each species and measuring them. Discover what different species will grow back, what area grows the most diverse range of plants, and which areas have the most growth overall.

7. Look at plants on a north-facing slope and a south-facing slope and notice the difference.

8. Examine plants having different adaptive strategies for recovery and regeneration at different stages of the successional process and in different communities on a year-by-year basis.

9. Have students compile a class list of all the types of plants they discover in the field. Compare the list with the list developed by students in previous years.
   a. What plants were found in all the years?
   b. What plants are new this year?
   c. What plants dropped off the list? Any ideas why?

10. Adopt-a-tree Observe a tree for a few months to see and document how it changes through the time you are watching it. Choose a deciduous tree and sketch it four times during the year. Visit the tree often to observe how it is changing. The intent of this exercise is to have the students observe how plants change over time, and to observe the nuances of the various stages of producing leaves, flowers, and other features if applicable.

11. More advanced students can make their own dichotomous key for their field guide. The key which they create can be placed at the beginning of the guide and used to help identify other plants in the field.

12. Invite younger students for a nature walk and have the older students show the children how to use the home-made field guides for identifying local plants.

13. Via online communications, students can compare the types of vegetation found in their area to what students from other schools find. This can lead to many possible research questions. For instance, students in different locations could compare the effect of latitude, longitude, topsoil, depth, soil moisture or altitude on the vegetation of their respective areas.

14. Students might enjoy learning about how various plants are used in medicine, as food and fiber, or by wild animals, or how Native Americans or other cultures utilized plants. The creation of a field guide can be a springboard for many ethnobotanical explorations.

15. Create a bulletin board showing plant species from around the United States.

DEVELOPING A FOREST MANAGEMENT PLAN: MANAGING THE IMPACT OF WILDFIRE ON COMMUNITIES AND ECOSYSTEMS

FOCUS QUESTION
What can forest managers do to improve forest health and reduce the risk of wildfire?

OVERVIEW OF LESSON PLAN
In this lesson students will synthesize all the information gathered in the previous lessons to develop a forest management plan. Students will use real data from the Los Alamos area to analyze forest conditions and develop a plan to restore and maintain ecosystem health. This activity will simulate the decision-making process and develop awareness of the debates and issues involved in forest-management decisions.

SUGGESTED TIME ALLOWANCE: 4 hours

LOCATION: Classroom

SUBJECT AREAS: Language Arts, Social Studies, Science, Math, Technology

STUDENT OBJECTIVES
Students will:
- Evaluate information from a range of resources and suggest a forest management plan to support a given problem
- Utilize previous data collected in the field and collect new data.
- Think critically and logically about the relationships between evidence and explanations, constructing and analyzing alternative explanations, and communicating scientific arguments
- Work collaboratively in small groups

VOCABULARY
- Forest Management Plan
- Resource Assessment

MATERIALS AND RESOURCES
- Field journals
- Pencils
- Forest Management Plan Worksheet
- Resource Assessment worksheets and maps
- Computers
- Internet Connection (optional)

PROCEDURE
1. Four resource assessments are provided. Divide students into management teams of from three to six students. Distribute the Forest Management Plan Worksheet and Resource Assessment for four areas. Class discussions will be more engaging if two teams of students work from the same resource assessment and students can compare the two approaches to the same problem.

2. Explain to students that they will develop a forest management plan that will establish a framework that restores and maintains ecosystem health in a fire-adapted ecosystem. Brainstorm ways in which this can be accomplished. Review management strategies like forest thinning, prescribed fire, pre-commercial thinning, logging, and other ideas.

3. Review the guidelines for a forest management plan. Students should understand that they need to collect data from the Resource Assessment, and use that data to determine if their stand is healthy or if it needs management.

4. Using the resource assessment and map, have students fill in the Forest Management Plan Worksheet. Students should summarize the information on the background of the forest and its history from the resource assessment. Next, students should summarize the current conditions of their forest stand. How does this compare with conditions that we consider to illustrate healthy stands of ponderosa pine?

5. Student should research methods of forest management on the Internet and in the library. Each group should decide which method or combination of methods would work best on their forest stand.

6. After students have produced their Forest Management Plan, they will make a presentation to the class.

EVALUATION:
Students will be evaluated on participation in class discussions, and completion of the Forest Management Plan.

EXTENSION ACTIVITY
Students may want to present their ideas at a community meeting, or publish their Forest Management Plan in the local newspaper or website.

GUIDELINES FOR DEVELOPING A FOREST MANAGEMENT PLAN

Adopted from The Forest Management Plan by the School of Forest Resource and Conservation, University of Florida

A forest management plan is a specific guideline for the way a stand of the forest is managed. The plan has a definite goal for the forest, and details a series of activities that will take place in order to meet that objective. In essence, a management plan will guide you from where you are to where you want to be. In this lesson, you will be given a resource assessment of the current conditions of a forest. You will determine if the forest is unhealthy and if it can be improved by specific treatments.

The information in your management plan should be simple, but with enough detail to be useful. Most management plans are designed to be reviewed every five to ten years, with adjustments made to accommodate the continually changing environment (from fire and bugs to landowner objectives) that is part of the natural resource management.

Parts of a Management Plan

- A statement of objectives
- A summary of the forest location and history
- A resource assessment that summarizes current conditions
- Management recommendations to reach the objectives
- An activity schedule of what will be done and when
- A description of what the forest will look like in the future

1. Statement of Objectives
   An objective is a desired outcome or future condition for your forest. Your objective will be to restore healthy and fire safe conditions in the forest by changing current conditions to more closely match those of the past.

2. Property Location and History
   Your management plan should include a description of your land taken from the resource assessment and map that you will be given. It should include a brief summary of the management history of your forest. Has it been cleared for recreation? Is there evidence of any other uses in the past? This information will give you some idea of your land s potential and may give you clues about what can be done with it.

3. Summary of the Resource Assessment
   Using the resource assessment, provide your plan with descriptive information about the natural resources on your land. It may include information such as stand types (e.g., dominant species, ages, understory), other vegetation communities, soils, water bodies, historical features, wildlife uses, and recreational opportunities. Summarize everything you know about your forest.

4. Management Recommendations
   Based on the resource assessment and your specific objectives, make recommendations for the entire stand of forest. Recommendations should outline a general set of treatments or operations to be done over a long term, with a

discussion of the expected results of each management action. General recommendations should be supplemented with specific recommendations, which are usually designated for five-to-ten year blocks of time. Specific recommendations may include the forest regeneration method(s) to use, where to plant wildlife food plots, when and where to burn, and which areas to remove trees.

5. Activity Schedule
   Create an activity schedule that tells when each recommended treatment will take place. Tell what you expect to accomplish with each treatment and why it is being done at a specific time.

6. Conclusion: The Future Forest
   Describe what your forest will look like when treatment is done, in one year after treatment, in 5 years after treatment, and 50 years after treatment.

POTENTIAL RESOURCES

http://www.sfrc.ufl.edu/Extension/ffws/mp.htm

http://www.eri.nau.edu

Forest Management Plan Worksheet

STUDENT SHEET

Date: ____________________

Names of Team Members:

Location of Forest Stand:

Property Location and History:

Summary of the Resource Assessment:

Objectives of the Forest Management Plan:

Management Recommendations for the Forest Stand:

Activity Schedule for Forest Management:

Conclusion: What will the Forest Stand Look Like at One, Five and Fifty Years in the Future?

37 acres

A plot study in the forest area found that 100 percent of the trees were ponderosa pine. The tree density averaged 730 trees per acre. The average diameter breast height of the trees was 10 cm. Only 10 large trees per acre are found on the site. Most of the trees form thick stands. The older trees are found in clumps of 3 to 6 trees. The small trees are all about 20 feet high. The large trees are up to 80 feet tall.

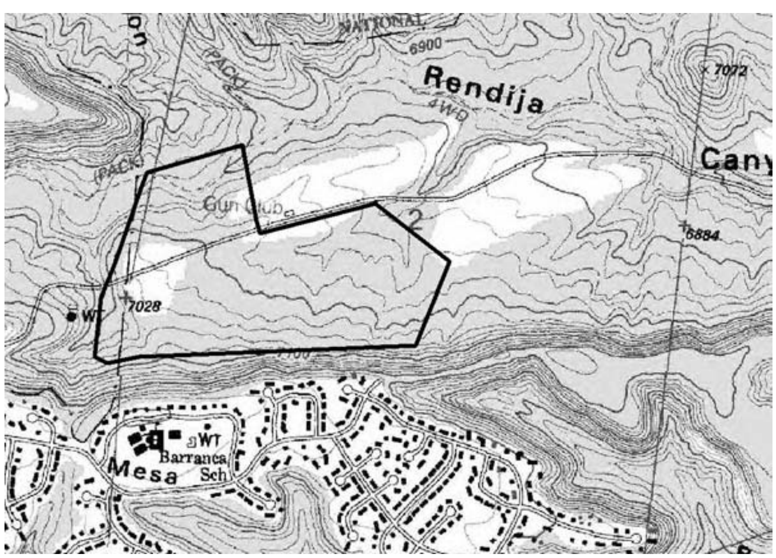
In the understory, the average number of species was 2. The ground is covered with a thick layer of pine needles. Plant cover averages about 20% of the ground. Thistle and cheat grass are common.

The forest is on the south slope of a canyon that runs out of the Jemez Mountains. The canyon is about 300 feet deep. The canyon walls are steep, but the forest sits on a flat spot above the canyon bottom. A stream channel is at the canyon bottom, but water flows in the channel only about 12 days a year.The forest is next to a recreational trail that is used by hikers, runners, horseback riders, mountain bikers, and motorcycle riders.

At least one archeological site is within 200 feet of the forest. It is an old village that was occupied around 1400. One-quarter mile downstream is a field from a homestead that was used around 1920. An old road runs up the canyon bottom.

Two endangered species are found in the canyon. Spotted owls live in the old standing dead trees. Peregrine falcons nest in the canyon walls.

Houses are found on the mesa south of the forest. The houses are about one-quarter mile away.



STUDENT SHEET

RESOURCE ASSESSMENT: BAYO CANYON

93 acres

A plot study in the forest area found that 80 percent of the trees were ponderosa pine and 20 percent were Gambel oak. The tree density averaged 510 trees per acre. The average diameter breast height of the trees was 50 cm, but some trees were 75 cm in diameter. About 25 percent of the trees were big trees. Some of the trees form thick stands. The older trees are found in clumps of 3 to 6 trees. The trees varied in size from 3 feet tall to 40 feet tall. The large trees are 100 feet high or more.

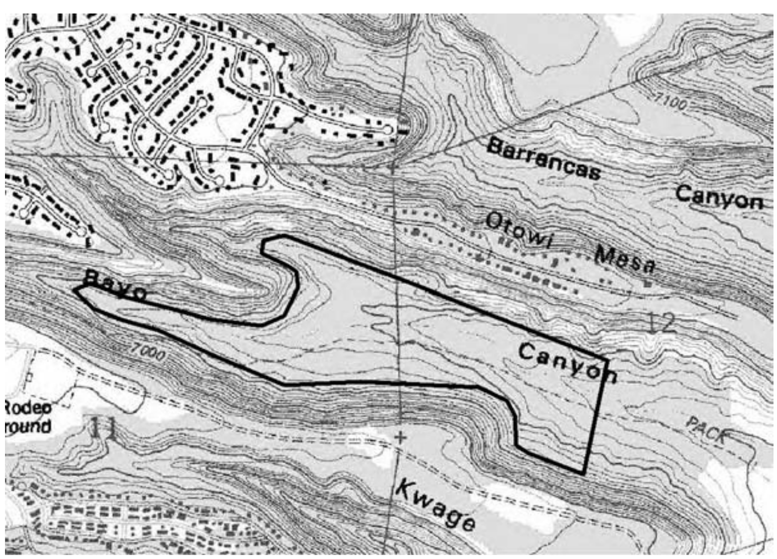
In the understory, the average number of species was 10. The ground is covered with a thick layer of tall grasses. Plant cover averages about 80% of the ground. Lots of dead wood is lying on the ground.

The forest is on the bottom of a wide canyon that runs out of the Jemez Mountains. The canyon is about 300 feet deep. The canyon walls are steep, but the canyon bottom is about one-quarter mile wide. A stream channel is at the canyon bottom, but water flows in the channel only about 12 days a year. The forest is next to a recreational trail that is used by hikers, runners, horseback riders, and mountain bikers.

One large archeological site is within a mile of forest. It is an old village that was occupied around 1400. An old road runs up the canyon bottom.

Two endangered species are found in the canyon. Spotted owls live in the old standing dead trees. Peregrine falcons nest in the canyon walls.

Houses are found on the mesas north and south of the forest. The houses are about one-quarter mile away. Many trees are found on the north slope of the canyon near the houses. A fire behavior study found that under dry conditions a fire start in the canyon bottom would spread at a rate of 3,000 feet per hour. Such a fire would reach out of the canyon in 15 minutes.



RESOURCE ASSESSMENT: QUEMAZON MESA

64 acres

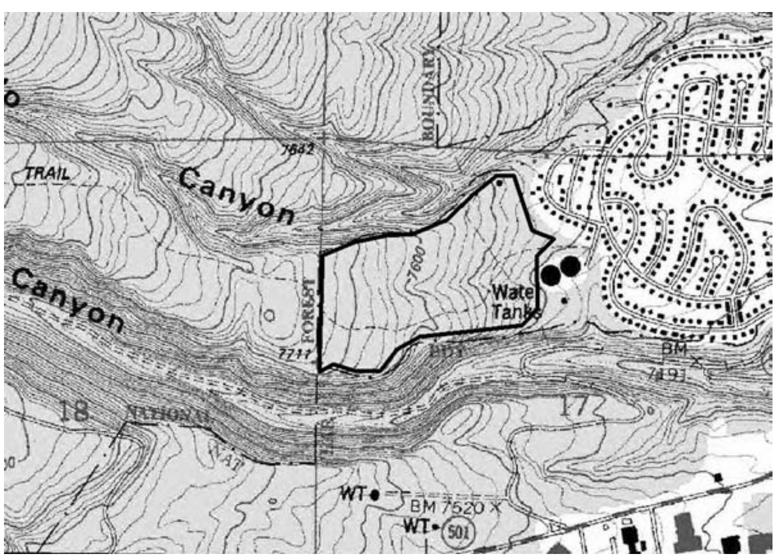
A plot study in the forest area found that 95 percent of the trees were ponderosa pine and 5 percent of the trees were aspen. The tree density averaged 660 trees per acre. The average diameter breast height of the trees was 15 cm. About 20 large trees per acre are found on the site. Most of the trees form thick stands. The older trees are found in clumps of 3 to 6 trees. The small trees range from 10 to 40 feet high. The large trees are up to 80 feet tall.

In the understory, the average number of species was 6. The ground is covered with a thick layer of pine needles. Grasses up to 2 feet high cover about 20 percent of the ground. Total plant cover averages about 60% of the ground. Thistle and cheat grass are common.

The forest is on a long mesa that extends east from the Jemez Mountains. The mesa is about 400 feet above the surrounding canyons. The canyon walls are steep, but the forest sits on flat ground. The forest has a recreational trail that is used by hikers, runners, and mountain bikers. The trail is an old road that runs up the mesa.

Two endangered species are found near the mesa. Spotted owls live in the old standing dead trees. Peregrine falcons nest in the canyon walls.

Houses are found on the flat ground northeast of the forest. The houses are about one-quarter mile away. In spring, the wind usually blows from the southwest. A fire behavior study found that under dry conditions a fire start in the canyon bottom would spread at a rate of 3,000 feet per hour. Such a fire would reach the houses near the mesa in 15 minutes.



47 acres

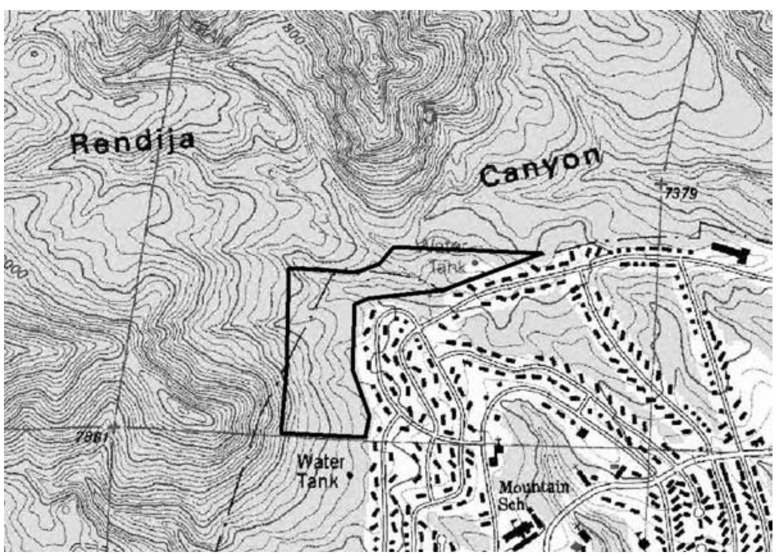
A plot study in the forest area found that 100 percent of the trees were ponderosa pine. The tree density averaged 540 trees per acre. The average diameter breast height of the trees was 10 cm. Only 10 large trees per acre are found on the site. Most of the trees form thick stands. The older trees are found in clumps of 3 to 6 trees. The small trees range from 10 to 40 feet high. The large trees are up to 80 feet tall.

In the understory, the average number of species was 4. The ground is covered with a thick layer of pine needles. Plant cover averages about 20% of the ground. Thistles and cheat grass are common.

The forest is on the south slope facing Los Alamos. The nearby canyon is about 100 feet deep. The canyon walls are steep, but the forest sits on a flat spot above the canyon bottom. The forest is next to a recreational trail that is used by hikers, runners, horseback riders, mountain bikers, and motorcycle riders.

Two endangered species are found near the mesa. Spotted owls live in the old standing dead trees. Peregrine falcons nest in the canyon walls.

Houses are found on the flat ground right on the edge of the forest. In some cases, the forest canopy extends right up to the houses.



BE PREPARED: CREATING A DEFENSIBLE SPACE

FOCUS QUESTION
What is defensible space and can it help save a house when a wildfire strikes?

OVERVIEW OF LESSON PLAN
In this lesson students will learn the principals of creating an effective defensible space around their home and property. They will learn the definition of defensible space and brainstorm ideas on how it is created. Using firesafe guidelines they will plan and create a fire-wise landscape design that will help protect their home from wildfires.

SUGGESTED TIME ALLOWANCE
4 hours classroom
2 hours homework

SUBJECTS: Science, Language Arts, Math, Art

STUDENT OBJECTIVES
Students will:
- Discuss the meaning of defensible space.
- Compare homes that have reduced the risk from wildfire and those that have not.
- List ways they can HELP protect their home from wildfires.
- Develop a Wildland Fire Hazard Severity Assessment Form.
- Plan a firewise landscape design that will meet the needs of their home and property.

VOCABULARY
- Defensible space
- Removal
- Reduction
- Replacement
- Vegetation
- Ladder Fuels
- Combustible Debris
- Separation distance
- Thumbnail sketch

TEACHER BACKGROUND INFORMATION
People who live in high risk wildfire areas are faced with the growing concern that a wildfire could damage or destroy their home and property. Every year many families lose their homes and possessions to wildfire. These losses can be minimized if home-owners take a pro-active approach to home safety. When homeowners take the time to become aware of appropriate safety measures and put forth the effort to implement those measures, they often greatly improve the ability of fire fighters to protect their homes, and will reduce their vulnerability to the destructive forces of fire.

Post-Visit LESSON PLAN

Defensible space is one of the primary determinants of a structure s ability to survive a wildfire. The goal of creating defensible space is to develop a landscape that provides an opportunity for firefighters to defend a structure against fire. When grasses, brush, trees, and other common forest fuels are removed, reduced, or modified in a yard, a fire s intensity or nearness to a structure decrease. That situation provides a space for firefighters to battle the blaze. Defensible space is not a guarantee that a structure will survive, but it often increases the chances of protection from wildfire.

MATERIALS

- Field journals
- Scratch paper 9x12
- 1 inch grid graph paper 34x26 (cut in half)
- Rulers
- Pencils
- Pink pearl erasers
- Colored pencils
- Prismacolor watercolor pencils (optional)
- Sharpie ultra fine markers
- Tag board
- Timer
- Firewise landscaping checklist

PROCEDURES

Warm-Up

Show an example of a typical house before defensible space measures have been applied. Ask students to list potentially flammable materials. What are some measures that could be taken to protect this home from wildfire? Are some homeowners reluctant to make changes that could reduce the threat of wildfire? Why?

Next show a picture of a home that has reduced the risk from wildfire by using defensible space measures. What differences do you see in the two pictures? If a wildfire came through your neighborhood, could your house survive on its own?

Group Discussion on Defensible Space

Write the definition of defensible space on the chalkboard. (Defensible space is an area around a structure where fuels and vegetation are treated, cleared or reduced to slow the spread of wildfire towards the structure and to provide a space for firefighters to work).

Strategy: Think-Pair-Share

Instruct students to: Think of three ways that you can reduce fire risk around your home. Take a minute to allow your thoughts to flow. After a minute of silent time pair off with the person next to you and tell each other your ideas and thoughts. After another minute tell students you will be asking some of them to share your ideas with the entire class.

For the first minute you will THINK individual and silent think time
For the next two minutes you will be part of a PAIR discussion with your partner
Lastly some will SHARE ideas class discussion

VARIATION: Think Pair Write or Think Write Pair

Strategy: Brainstorming
Creating a truly defensible space requires that homeowners maintain their whole property. What are some ways that property owners can reduce the risk of wildfire? Develop and post a working list that can be added to during the unit.

1. Hand out a copy of the firewise landscaping checklist. Ask students to read over the list and note the items that are already there. Discuss the contents of the list.

2. Students will work in teams of 4 to develop a risk assessment form. What are the most hazardous / troublesome issues a firefighter would identify in trying to protect a property?

3. Review the professional Wildland Fire Assessment Form that is often used for professional assessments. What hazards did you catch? Which did you miss? How might you customize your form (having seen the professional one) to get a final assessment tool?

4. As a homework assignment each student will take the form home and assess their own home and property and discuss with their parents what can be done to improve their risk of wildfire damage.

5. Students can then design a defensible space plan for their home (see below).

PROCEDURE FOR DEFENSIBLE SPACE DESIGN

1. In their field journals students will list all the steps they need to take to reduce the risk of wildfire damage to their home and property.

2. Beginning with scratch paper they will construct a thumbnail sketch of their home and develop a defensible space landscape. (Thumbnail sketches are very quick, loose drawings. Sometimes they look a little messy but they help with the planning of the design without having to worry about making mistakes.) (It helps to have students work from photographs of their homes; using front, side, and back views.)

Post-Visit LESSON PLAN

3. After careful editing of the rough draft plan, students are ready to draw their design on graph paper. Stress that they lightly draw where they want things to go and fill in the details later. Color should be added sparingly after the design is complete. Markers are not recommended as they bleed through the paper. A list of at least five or more changes should be typed and attached to the finished project.

4. Glue the finished graph paper to tag board for support and laminate if desired.

5. Share the finished projects with the class and display in a suitable location.

EVALUATION

Students will be evaluated on participation in class discussions, group work, completed defensible space designs, and informed presentations.

EXTENSION ACTIVITIES

Write an essay on how you can increase community commitment and participation regarding defensible space.
Design an exhibit such as Who Wants to be a Wildfire Survivor?
Design a defensible space plan for your neighbor.
Invite a local builder to the classroom and discuss firewise construction methods used.
Design a new house with recommended defensible space suggestions.
Present student designs at a local community firewise meeting.
Conduct a survey with community members. Address these questions: What did you know about the history and health of your forests? What did you know about the risk of wildfire? What did you know about fuel/hazard mitigation? How could land and resource managers and other officials better communicate with the public? Hold a public meeting and share the results.

POTENTIAL RESOURCES:

http://www.firesafeidyllwild.org/firesafeweb/defensibleSpace/step1/dist...

http://www.usfa.fema.gov/safety/landscape.htm

http://www.firewise.org

Name____

Be Prepared: Creating a Defensible Space
Assessment Questions

Comprehensive Paragraph: List three or four things a person can do that will make your house safer from wildfire. Then write a short explanation of why your list will work.

____
____
____
____

Matching:

Defensible space
Removal
Reduction
Replacement
Ladder Fuels
Combustible Debris

a. fuels that provide vertical continuity between the surface fuels and crown fuels in a forest stand, thus contributing to the ease of torching and crowning.
b. items that catch fire and burn easily; flammable
c. eliminating entire plants, particularly trees and shrubs, from a site.
d. clearing away plant parts, such as branches or leaves. An example would be pruning dead wood from a shrub.
e. what you do when you substitute a less flammable plant for a more hazardous type of vegetation.
f. an area around a structure where fuels and vegetation are treated, cleared or reduced to slow the spread of wildfire.

True or False:

1. Creating a truly defensible space requires that homeowners maintain an area of at least 15 ft. from the house.
   a. True   b. False

2. Removing or reducing grasses, brush and trees from near a structure will always keep a home from burning.
   a. True   b. False

Multiple Choice:

What is the primary way of saving a structure from wildfire?
a. creating defensible space   b. install room extinguishers
c. coat the roof with a fire retardant paint   d. remove all crowning fuels

Combustible debris includes which of the following?
a. old dry limbs   b. newly planted shrubs
c. cedar shingles on the house   d. all of the above

Which of the following is not an effective method of creating defensible space?
a. removal of vegetation   b. reducing vegetation
c. replacing vegetation   d. replanting vegetation

BE PREPARED: CREATING A DEFENSIBLE SPACE
ASSESSMENT TEACHER MASTER SHEET

Comprehensive Paragraph: List three or four things a person can do that will make your house safer from wildfire. Then write a short explanation of why your list will work.

Becoming aware of dangers through education.
Replacing and replanting vegetation.
Removing, reducing, or modifying landscape.

Matching:
Defensible space f
Removal c
Reduction d
Replacement e
Ladder fuels a
Combustible debris b

True or False:

1. Creating a truly defensible space requires that homeowners maintain an area of at least 15 ft. from the house. False

2. Removing or reducing grasses, brush and trees from near a structure will always keep a home from burning. False

Multiple Choice:

What is the primary way of saving a structure from wildfire?
a. creating defensible space

Combustible debris includes which of the following?
d. all of the above

Which of the following is not an effective method of creating defensible space?
c. replacing vegetation